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NEW TEACHING AIDS FOR THE AMERICAN CLASSROOM, A SYMPOSIUM HELD AT THE CENTER FOR ADVANCED STUDY IN THE BEHAVIORAL SCIENCES, NOVEMBER 13-14, 1959.
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A SYMPOSIUM ON THE STATE OF RESEARCH IN INSTRUCTIONAL TELEVISION AND TEACHING MACHINES WAS HELD NOVEMBER 13-14, 1959, AT THE CENTER FOR ADVANCED STUDY IN THE BEHAVIORAL SCIENCES, STANFORD, CALIFORNIA. IT INVOLVED A SMALL GROUP OF SCHOLARS, INFORMED AND EXPERIENCED IN RESEARCH ON THE NEW MEDIA, WHO DISCUSSED CURRENT DEVELOPMENTS AND FUTURE RESEARCH DIRECTIONS. THE CHIEF PAPERS OF THE CONFERENCE WERE PUBLISHED IN THIS VOLUME WITH A FOREWORD BY WILBUR SCHRAMM. THERE ARE THREE MAJOR SECTIONS--(1) "THE CLASSROOM OF TOMORROW" CONTAINS PAPERS BY RALPH W. TYLER, ROY M. HALL AND WILLIAM E. SPAULDING, (2) "RESEARCH BACKGROUND" CONTAINS PAPERS BY ERNEST R. HILGARD, JOHN W. RILEY, JR., AND WILBUR SCHRAMM, AND (3) "RESEARCH FOREGROUND" PRESENTS PAPERS BY C.R. CARPENTER, CHARLES F. HOBAN, J.H. KANNER, AND A.A. LUMSDAINE. (JC)

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New Teaching Aids

for the American Classroom

A symposium on the state of research in instructional television and tutorial machines: CARPENTER • HALL • HILGARD • HOBAN • KANNER • LUMSDAINE • RILEY • SCHRAMM • SPAULDING • TYLER • Stanford, 1960

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FOR THE AMERICAN CLASSROOM

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New
Teaching Aids
for the American Classroom

A symposium on the state of research in
instructional television and tutorial machines, held 13 and 14 November, 1959,
at the Center for Advanced Study in the
Behavioral Sciences, ~~under the auspices~~
~~of the United States Office of Education~~
~~and the Institute for Communication~~
~~Research, of Stanford University~~

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF EDUCATION

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FOREWORD

Just this side of the horizon but coming fast are certain new teaching devices which are likely to make a profound change in what happens in the American classroom.

Chief among these new devices are instructional television and tutorial machines. In their potential importance to our schools, they have been compared to the textbook. And they may have much more impact than the textbook, for whereas the text developed slowly over several hundred years, these new devices are coming into being and into use in only a few years, and at a time of great need.

It seems uncommonly good fortune that such devices should come into use just at the time when our schools are being challenged both in quantity and quality. Overcrowded and understaffed already, schools are now being asked to absorb an additional population bulge. At the same time as they are asked to teach ever greater numbers of slow and average pupils, they are also being asked to provide special opportunities for the brightest pupils, and over-all to raise the quality of their product beyond anything the American public school has ever before been able to produce.

The real importance of these new machines is that they offer a way to relieve the present over-worked and over-challenged classroom teacher from some of the drudgery of teaching facts and skills, from some of the drilling, from trying to appear expert in more subjects than anyone can possibly be expert in, from trying to provide more demonstrations and trips and visits than any one school can possibly provide. By relieving the teacher of such time-consuming, thankless, and often inefficient or impracticable activities, they offer a chance to free time to help individual students, and to help all students acquire the abilities to solve problems, think critically, appreciate art and literature, and develop their creative and inventive talents -- kinds of teaching which are not done so well by machines -- and thus to raise the quality of education generally.

It is an attractive and tantalizing prospect. But this is a rush job. In a comparatively few years we must come to understand, learn to use, and evaluate the worth of these new devices in their various forms. In other words, if we are going to use them well we must learn as much about them in a few years as we have learned about textbooks in hundreds of years. It was to meet that urgent need for trial and research that much of the Defense Education Act, and in particular Title VII, was written and passed by the Congress.

On November 13 and 14, a group of scholars met at the Center for Advanced Study in the Behavioral Sciences, at Stanford, California, to talk about how research could contribute to the understanding and use of these newer instructional media.

Among those present were the contributors to this volume, members of the research administration staff of the United States Office of Education, some editors of scholarly journals in this field, and certain Fellows of the Center.

The conference was financed in part by the Office of Education, and was directed to the strategy and tactics of research in the new teaching media under the research programs provided for by the Defense Education Act. The meeting did not grow out of dissatisfaction with existing research programs, but rather from a recognition of the remarkable opportunity which the new media offer American education, and the unprecedented opportunity which the Defense Education Act offers scholars, administrators, and teachers to test, understand, and make wise use of these new devices.

Both by policy and by law, the Office of Education is constrained in its relationship to research of this kind. For one thing, the Office does not support operational research defined as the kind of research which settles the unique problems of one school system or educational institution. Rather, it seeks to support research which is of broad interest and application; any other policy could hardly be defended as responsible use of limited public funds. Again, the Office makes no attempt to impose its research wishes or plans on research men. Rather, it is responsive to suggestions and proposals made to it by these research men. At the same time, it is charged with a responsibility which it takes very seriously -- maintaining a high quality of research in order that American education may derive maximum benefit from Defense Education Act funds. Therefore, it is of the greatest importance that there be some consideration of strategy and tactics in these research fields: What are the topics of broad interest and importance? What are the topics in which a scholarly advance would trigger an advance along a broad line? What are the questions that must be answered before each of these media can be used confidently and effectively? Which are the areas in which the greatest need is for basic research, and which are the ones in which the emphasis should be on problems of application? In other words, what allocation of research energies and funds would now maximize the increment of the effort, and the utility of the new media?

Answering these questions is not a responsibility solely of the Office of Education and its advisory committees. Rather it is shared with the research men of America from whom must come the ideas, designs, proposals, and ultimately the research itself. Indeed, it is shared also with the educators of this country, and the citizens who pay for education. It is in the interest of all of us that the new teaching devices be understood as well as possible in order that they may contribute as soon and as fully as possible to education.

This was the intent of the Office when it suggested to the writer of this foreword that he assemble a small group of scholars, informed and experienced in research on the new media, to talk about where we stand in these areas of research, and in what directions research ought to be moving. Because the discussion of such questions is of interest and importance far beyond the small circle at the conference, the chief papers are being published in this volume.

In a book like this, however, it would be very difficult and expensive to reproduce the discussion that took place at the conference. Therefore, perhaps I may be pardoned for inserting a few paragraphs which represent one man's opinion of some of the more important threads that ran through the discussion.

1. A moratorium on repetitious research

There was general agreement that more than enough studies have now been built around such questions as, can television teach? or, can television teach as well as the classroom lecture? There is no longer any reasonable doubt that television can teach as many facts and skills as the same lecture given in the classroom. If this needs to be demonstrated anew in order to convince a local school system or educational institution, then it should logically be supported by local rather than national funds. There are now more important and significant uses for research money.

2. Making programs for the tutorial machines

One of these uses -- and clearly one of the high priority needs in this field -- is for a considerable amount of work focussed on making programs for the tutorial machines. The process of constructing such programs, if wisely done, is itself a research process, for the programs should be tested piece by piece during construction, not only to improve them but also to build up principles and guides for all programming.

The tutorial machines (or "teaching" or "learning" machines, as they are variously called) are the newest and most "different" tool among the instructional media. The strength of instructional films and television is essentially distributive: they can assemble in a classroom all sorts of excellent teaching and demonstration and then distribute it widely and quickly. In other words, they can share excellent teaching. But this teaching is still controlled by the lecturer or broadcaster, and is not very responsive to the special needs or individual learning rates of different viewers. The strength of the tutorial machine, on the other hand, is that it provides a learning experience which is under the control of the student, rather than the broadcaster or film-maker. Thus the machine fits the learning speed of the individual child, provides as much practice as the child needs, and lets the brilliant child go swiftly, the slower child go slowly, without either interfering with the other. A well-programmed machine of this type offers the same kind of help as an individual tutor, but frees the teacher from such burdensome and immensely time-consuming duties.

The bottleneck in putting these extremely promising mechanical tutors into use is in programs, rather than machines. A number of machines of various kinds are now available, in experimental if not in commercial models, and, indeed, the form the commercial models will take depends largely on the kinds of programs they will have to carry. Therefore, the next step is to concentrate on programming.

This is important and fruitful beyond the mere production of devices to get the machines into use. Making a program requires the maker to examine the psychological as well as the logical organization of subject matter. Because the best way to accomplish this, and to make programs in this preliminary stage of the art, is to combine the talents of teachers and behavioral scientists in the task -- because of this, the task brings together the study of the substance of a course and the study of the learning process, and forces experts in one to make common cause with experts in the other. Furthermore, by testing programs as they are being constructed it is possible to make some fundamental contributions to the understanding of the way children learn. Thus a concentration on making and testing programs for these machines promises to contribute to the richness and understanding of all teaching and learning.

3. The social context of the new media

It was pointed out that relatively little has been done to set the new instructional media in their social context. When one of these media enters a classroom it comes into a working task group with a complex set of norms, roles, and subgroups. Each of the children in the classroom, and the teacher as well, has also a set of group memberships outside the classroom -- family and peer groups, chiefly -- which profoundly influence his motivation to learn and his general behavior and accomplishment in school. Some recent experiments indicate that these influences are especially interwoven with the communication and learning behavior of the child. For one thing, we know that a child's concern for reference groups will have much to do with determining what he remembers from the mass media, and that a child who is not well anchored in peer groups will make different use of television from a child who is well anchored. Research reported at the conference suggests that a child's use of television outside school may determine in large part the skills he brings to learning from television in the classroom, and his general set toward television as a teaching medium. There was also a general feeling that some of the new media make it possible, much more effectively than before, to use the home as a source of reinforcement. For example, one school system now rebroadcasts televised lessons in foreign languages at a time when pupils and their parents can view and practice them together. And it has long been known that the norms and social relationships built up in the classroom have much to do with the learning efficiency of the pupils.

Therefore, the conferees talked about the need of some solid studies of the new instructional media in their relation to the various social systems which impinge on their use. A start at this might be made by means of close studies of a few classrooms into which some of the new media are introduced. The relation of the student's use of mass media outside the classroom to his learning from the media inside the classroom might well be examined and so might the use of home experiences for reinforcement of the instructional media. It was suggested also that it would be helpful to learn more than we now know about innovation in a school social system. The new instructional media, of course, represent a considerable and sometimes shocking innovation. Therefore, their adoption is often resisted, and when they are adopted they sometimes temporarily disrupt a classroom or school. From studies of agriculture, drugs, and a few other fields, we now know something about the broad patterns of innovation, and some of this is applicable to schools; but more study is called for in the context of education.

4. Instructional media as systems

Although some impatience was expressed, as has already been noted, with research aimed at discovering whether the new media could "teach," there was general recognition that much remains to be learned about how and under what conditions they can best teach. One of the conferees proposed that each medium be considered as part of a teaching-learning system, and that research be designed in such a way as to vary elements in that system within a known context. These elements would include the content and arrangement of the medium itself, the way it is presented, the combinations of learning activities built around it, and so forth. Thus, for example, certain ways of combining these media, such as television with tutorial machines, may be immensely more effective than either one alone; and the activities built in the classroom around the televised lesson may be more influential than the lesson itself in determining how much is learned. One of the pressing problems of content is how to make the rate of televised content fit the widely varied learning rates in the classroom; this, of course, must be studied in context to be meaningful. Indeed, the hope was expressed that by systematically varying the elements and carefully describing the context, researchers might make their results easier to apply.

5. Motivation to learn

One of the important contextual elements in the teaching-learning system is, of course, the motivation of the learners. The problem of maintaining high motivation undoubtedly increases as the new media become less new, and proportionally to the lack of feedback and supervision. Therefore, it is a built-in problem which has to be compensated and prepared for in planning the content and classroom use of all instructional media. So far the conditions of attaining high motivation for the use of these particular media are not well known. In addition to considering rewards and punishments, however, research must take into account also such personal qualities as anxiety levels related to the new media, and self-images as affected by "impersonal" teaching. For example, there have been numerous reports that, while students learned as much from a televised class, they liked it less than a face-to-face class. If this is the case, one would expect that motivation might be hard to maintain over several such courses; and that both the content of the course and the activities built around it need attention.

6. Making research useful

There was considerable speculation among the conferees as to why relatively little application of research to these new media has so far been made. For example, learning theory has been of relatively little use to them. Basic research of any kind has made surprisingly little contribution to their development. And this is not because the amount of research has been comparatively small, for perhaps no teaching medium has ever been introduced to the schools accompanied by so much research as has instructional television.

The chief reason is probably that not enough research has been of that kind to build a bridge between theory and practice. In natural science much of this kind of activity is called developmental research. In the case of instructional media it might be referred to as contextual research. Its task is to establish the conditions under which laboratory-based theory applies to the less aseptic, less neat, less controlled world of the classroom; or under which the results of one study apply to other situations. Without an understanding of these limiting conditions, we can never confidently apply the results of one study elsewhere. Therefore, the conferees expressed the hope that such contextual or developmental research would not be looked down upon or subordinated in the program. They expressed the opinion that at this stage of the new media, developmental work is often more important than a trivial experiment.

It was the general hope of the conference therefore that research would move forward on a broad front, including both experiment and developmental activities, choosing topics from promising areas, and combining topics and situations in such a way as to make the results additive. Another specific suggestion was made: that a program of small grants -- a few hundreds or thousands of dollars -- might be maintained in order to let a scholar occasionally follow out an unusual idea, or make preliminary tests on a set of hypotheses which are challenging and insightful but for which there is no evident theoretical backing. Opportunities like this, it was felt, might keep the research program from freezing into premature orthodoxy.

Finally, the conferees pointed to another reason for the lack of broader application of research in these fields. No science has ever been able to bring many of its results into public use without expert appliers. Medicine became broadly useful when it developed physicians, surgeons, nurses, and pharmacists. Physical science made a great step toward broadening its usefulness when it developed engineers. So the new educational media will also need their expert appliers. Many of these unquestionably will have to come from within the school system. Perhaps the supervisor is the most likely candidate in public schools. But the supervisor, or some other person or persons in a school system, will have to become expert in applying research results to specific conditions before the new media will be used as effectively as they can be. The hope was expressed, therefore, that teaching and supervisory personnel would have increasing contact with research activities in this field. In this respect, the making of programs for tutorial machines, requiring, as it does, teachers and behavioral scientists to work together, may turn out to be a contribution to the training of appliers, as well as to the devices of teaching, and to knowledge.

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This is merely one man's report on the discussion at the conference. The papers in the following pages will help to round out the report.

Neither this brief report, nor the papers, however, will convey adequately the sense of challenge and of opportunity which pervaded the meeting at the Center. In this period of challenge to our educational system, we are fortunate to have the instructional media to help us meet the challenge; and doubly fortunate to have such support as the Defense Education Act behind our efforts to understand and apply the new media. Just as what we do with the new media will determine in no small part how well we meet the challenge to education, so what we learn by research will help to determine how well we use the media. Therefore, it is of the utmost importance that the strategy and tactics of research in this field be as wise and farseeing as possible. That was the tone, implicit or explicit, of the conference.

Wilbur Schramm

Center for Advanced Study
in the Behavioral Sciences
November, 1959

NEW TEACHING AIDS
FOR THE AMERICAN CLASSROOM

I

THE CLASSROOM OF TOMORROW

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SOCIAL TRENDS, AND PROBLEMS FOR TOMORROW'S SCHOOLS

By Ralph W. Tyler

Dr. Tyler, who is Director of the Center for Advanced Study in the Behavioral Sciences, and was formerly Chairman of the Department of Education and Dean of the Division of Social Sciences at the University of Chicago, here examines some socio-economic changes in American society, predicts their effects on the school, and lists some proposals for dealing with them.

Any effort to predict the changes likely to take place in American schools is based on some conception of the factors influencing these changes and some data regarding the current trends in these factors. Since the schools are so central to American life, they are related to many facets and this means that several kinds of predictions are possible, each based upon developments in one or more different aspects of our complex life. My paper attempts to look at changes in the schools by examining first the socio-economic changes in American society and predicting their influence on the schools.

Social Trends and their Relation to Changes in the School

The most obvious social change in the past dozen years is the increased birth rate in America. During the 1930's, the average annual births were about 2,000,000. Now, there are more than 4,000,000 babies being born each year. The effect on the schools is to require suddenly many, many more buildings, more teachers and other school personnel. These demands come at a time when there is a relatively smaller proportion of our population in the age brackets from which the needed staff must be drawn, that is, from 25 to 60 years of age. As a result, the classrooms of tomorrow are likely to be inadequate in numbers both of buildings and of professional staff members.

A second social change involving education is in the addition of new educational functions that were not recognized in earlier years, at least generally, by the American schools. When Jefferson wrote clearly and passionately for the development of public education in the United States, he pointed out the importance of a literate citizenry, and the task of the schools as he saw it was to prepare that literate citizenry. With changing times, what is required to be a literate citizen is considerably more than what was required in Jefferson's age, so that this has extended their function and the length of schooling needed to meet that requirement. With the great increase in immigration which took place in the 1870's and on through 1910, Americans came to expect another function to be performed by their schools. The immigrants in large measure came to the new world to provide opportunities for themselves, and especially for their children, that were not available in the old world. They quickly recognized that education was a major means of opportunity in America, a means by which children of the less privileged classes might rise in the occupational and social scale. "From the log cabin to the White House" was an accepted ideal of American society and the schools were increasingly expected to serve this function of social mobility. In fact, much of the impetus involved in the rapid development of the American high school was a response to this great demand for opportunity -- opportunity for immigrants, opportunity for many others who were not immigrants, who saw a chance through education for their children to attain a level of life, responsibility and position that was not possible to them, their parents.

In the period from 1917 to 1930, another function was laid upon the schools. During the First World War, the shortage of skilled workers was met by the development of short, formal programs of training. Heretofore, skilled workers, such as bricklayers, carpenters, blacksmiths, and machinists, were prepared by the apprenticeship system. The war brought a sharp increase in demand that could not be met quickly enough by apprentice training. Vocational training based on job analysis was tried by the armed forces and found to work. This stimulated many efforts to introduce vocational training in the high schools. The passage of the Vocational Educational Act gave national recognition to the function of the schools in preparing skilled workers.

During the depression period there were few jobs available and no place for young people to go except to continue further in school. This led to a re-emphasis upon the value of citizenship education and general education began to be greatly emphasized. The end of the depression involved the rapid industrial expansion which took place just prior to our entry into the war and this was followed by the much greater dynamic nature of our economy since. In fact, great occupational shifts have been taking place in America for a century but the rate of change has been greatest in the past twelve years. For example, in 1900, approximately 50 per cent of all those gainfully employed were employed on farms. Now about 12 per cent of our population is employed in agriculture and yet we produce more agricultural products than we have ever produced because of the mechanization of agriculture, the development of hybrid seed, the development of fertilizer and the use of other aspects of technology that have grown out of research. Now the U.S. Department of Agriculture estimates that about a million people are moving out of farming every year so that we may expect in ten years or less that only about 7 per cent of our total working force will be employed in farming. To cite another example, at the turn of the century, approximately 30 per cent of our people were employed in unskilled labor. Now this percentage is down to less than 10. There were about 18 per cent employed in skilled labor; now it's about 13 per cent.

As these shifts have taken place opportunities are closing rapidly for people to engage in gainful employment with limited education, for the expansion in employment has been largely if not wholly in fields requiring more education. Percentagewise, the greatest expansion has been in the field of science and technology, including engineering. There are now employed in these occupations nearly fifty times the percentage of the labor force that was listed in these fields at the turn of the century. This is possible because the number employed in these fields sixty years ago was very small. A second large area of expansion is in the people employed in the health services. Although the number of physicians has increased recently by only about 50 per cent, the total number engaged in the health services, including the nurses, the practical nurses, the nurse's aides, the orderlies, the clerks, the laboratory technicians and the like, is more than five times the number in 1930. Great increases have also taken place in the number of people employed in the recreation and entertainment services. These are not all in television; a great many are in parks and a variety of other kinds of entertainment. There have been large increases in the numbers employed in publishing and printing and distribution of books and magazines. There are very large increases in the number of people employed in the field of accounting and controlling, including the controlling of the automated industry, the operation of computing and accounting machines and the like. One of the great areas of increased employment, as we all know, is in teaching and educational work generally. More than 1,300,000 people, two per cent of our gainfully employed, are engaged in education, and the number is increasing.

These illustrations have been presented to indicate that one of the things that has happened with the shift taking place in the technology of production, is that we need many fewer people in jobs requiring a limited amount of education. An increasing number are employed in occupations that require more education. We can no longer say to a person at the end of the tenth grade, or whenever he passes the age of compulsory education, that if he drops out of school he can find a job. There just aren't that many jobs. There are some, but relatively few, available to persons with less than high school education, and the number open to persons having only a high school education is diminishing. Another function of the schools is now to provide the base in general and specialized education for a much higher level of occupational skills.

This great change in the American economy has brought another function of the schools to the fore. Since about 20 per cent of the working force can produce the goods for our material needs, the other 80 per cent would be unemployed were there not a great demand for non-material services, such as health, education, recreation, reading, music, art, and so on. We now recognize that this demand for non-material services is a product of a higher level of education. The demands for books, for music, for art, for education all increase with increases in the level of education of the people. A free economy like ours requires education to provide persons both to produce and to consume the many non-material services.

The second change in the American school, then, is the expectation that it will perform five functions for society in addition to the very important function it serves the individual in providing opportunity for his self-realization.

A third change is closely related to the second. Because of the greater demand for higher level education, we see today a greater concern in the schools for "excellence" or "quality" in education. A number of manifestations of this are readily apparent. With more high school graduates going to college the high schools are giving more attention to college preparation. More attention in teaching is being given to developing understanding on the part of the student and less to rote memorization, more effort is focussed on developing student interest in study and ability to carry on independent lifelong inquiry, more emphasis upon problem-solving rather than finding answers in textbooks, more attention in literature and the arts to interpretation and broader and deeper appreciation. Looking over new courses of study, you will see shifts like these in the avowed objectives of schools, shifts not unrelated to the enlarged functions the schools are expected to serve.

Problems Involved in Accomplishing the School's Tasks

The problem most commonly recognized as standing in the way of accomplishing the tasks now expected of the schools is the shortage of adequately prepared teachers.

The teachers of today are drawn from the population in which two million children were born each year, and they are responsible for the education of children of a population in which four million are born each year. This means a continued pressure on the limited number of adults to provide for the very large number of children.

A second problem is the maintenance of continued growth on the part of those engaged in teaching. As our society has matured, the teaching staff is serving a longer period. In 1920, the average teacher taught only a little more than three years; now he teaches about fourteen years. With increasing length of service, attention is shifting from a preoccupation with the initial preparation of teachers to the maintenance of a teaching staff continually alive and developing to meet changing conditions. Some preliminary studies indicate that the typical teacher improves during the first three or four years of experience and then his professional competence flattens off like a plateau and begins to drop down as his interests turn to other things. In such cases, teaching becomes a routine rather than a professional activity, and the more difficult educational tasks are likely to be poorly done.

A third problem is the public resistance to higher support levels for buildings and for teachers. The need for much larger funds to care for the four million children now born each year presses the public at the same time that the increase in population and its urbanization require many other public services, such as public health, roads, police and fire protection. These greatly increased costs of public services require sharp increases in taxation and in many communities there is a great deal of public resistance. You may recall that just last week New York which is supposed, generally, to be the leader in willingness to support education, turned down a five-hundred-million-dollar bond issue for the buildings of New York City in spite of the fact that the children to use these buildings are already born and the needs are evident. This is only one example of the increasing resistance to higher levels of support for education.

A fourth problem is the ineffectiveness and inefficiency of group teaching as it is now conducted. In group teaching as it is typically conducted, the teacher tends to focus attention upon the pupils representing the middle level of achievement in that class, and he selects materials and develops learning experiences pretty much with these middle-level pupils in mind. The pupils above the middle-level of the group are often quite inadequately challenged and make much less progress in learning than they could if the materials and the experiences were sufficiently demanding. The pupils below the middle level of the group often find the material and the expectations made of them so much higher than they feel able to do justice to that they become discouraged and do little. Although this focus upon the middle-level pupils in a group is typical of group teaching, I am not implying that the group teaching must necessarily be like this and be inefficient and ineffective. But it is a present problem.

A final problem I wish to mention is the inadequacy of the public's perception of the nature and significance of the educational job. The public perception has an important effect on pupils and staff. The current discussion in the press in connection with the TV investigation indicates pretty clearly that the public thinks of education as being something like a quiz program. Although leaders recognize the need for developing understanding and intellectual analysis and problem solving, and more basic skills and interests, the public generally does not distinguish between memorization and other educational purposes. The public commonly criticizes the schools in terms of pupils who cannot spell common words or locate the capital of Australia. The public does not generally recognize the much more difficult and more involved tasks of the schools and what these require in terms of the effectiveness of teaching. The public is even less likely to appreciate the greater difficulties in teaching when more and more young people are going through high school and more and more are going through college, where the complexity of learning is much greater.

Proposals for Dealing with These Problems

The five problems outlined above are being given increasing attention by leaders in schools and colleges. A number of proposals are seriously under consideration as promising ways of solving the problems or at least providing partial solutions. The proposals I shall mention have largely been derived from three sources. The first was a conference on the public school curriculum held here at the Center in January 1959 at which representative public-spirited laymen, scholars, scientists and school people considered together the policies and strategies required for the development of a curriculum adequate to the school's tasks. The second was a seminar held at the Center in July 1959, sponsored by the Fund for the Advancement of Education, and involving a number of educational leaders. This seminar dealt with the directions experimentation in education ought to go and what kinds of experiments look most promising. The third source is the current work of the U.S. Office of Education and of the National Science Foundation in research and development of curriculum and teaching materials. These three are limited sources but they are varied and suggest kinds of proposals in mind. One clearly popular proposal is to establish a number of curriculum study groups. These study groups are of two sorts. One is represented by one of those supported by the National Science Foundation called the Physical Science Study Committee which is headed by Jerrold Zaccarias, physicist of M.I.T., and involves other leading physicists and teachers and administrators in the schools. Their task, begun three years ago, has been to re-think and to re-design the high school physics curriculum. Since then, the National Science Foundation has provided support for a mathematics study group, and one in biology. The Fund for the Advancement of Education has supported a study group in the humanities at the high school level. Other study groups of this sort are forming. These are efforts to bring together the scholars or the scientists with the teachers and administrators to try to think through jointly just what the curriculum in a particular field ought to be in the light of two things -- one, the changes that have taken place in the content itself; and the second one, the kinds of ways in which this content, its knowledge, its skills and its outlooks can be significant to a citizen in modern America. These groups are producing courses quite different from those they supersede. For example, in the immediate past, physics textbooks have become bigger and bigger by the addition of new applications of physical principles and new topics like nuclear physics, but there has been no re-thinking of the whole course. The Physical Science Study Committee has decided that the basic tools for understanding physical science and for dealing with the problems of physical science on the part of the citizen require two things. They require certain concepts, about thirty-four in number, which serve as ways of thinking about and understanding the phenomena. They also require certain skills, such as skills in analyzing problems, in dealing with empirical data and drawing generalizations from the data and in predicting probable consequences of given forces operating in the physical realm. The new course, then, does not have thousands and thousands of specific facts as its objectives, but the understanding of these thirty-four concepts in a variety of contexts and with reference to a variety of phenomena, and the abilities required to carry on certain kinds of scientific inquiry at the level that the junior in high school might be expected to do. The Committee has also developed for the new course text materials, a laboratory manual, monographs on interesting related topics, motion pictures to illuminate some of the topics, and simple experimental equipment. In general, each curriculum study group is rethinking the curriculum in a particular field, seeking first to clarify the objectives and often to develop new and different objectives from those commonly emphasized, and then to devise various kinds of learning experience, that is, to outline the things the students can do that are likely to attain these objectives.

In some cases, curriculum studies are experimenting with very different courses from typical ones. For example, the U.S. Office of Education is supporting research by a professor of mathematics at Stanford who is teaching geometry in the primary grades. He finds that young children can understand and use simple geometrical concepts.

Another type of study group proposed is one concerned with the problem of bringing together in the curriculum these various subjects so as to provide for proper sequence in terms of what we know about child development at various ages, and to provide an effective balance and relation among the subjects. These groups are concerned not only with the questions of what physics and mathematics and English and other subjects should be taught and how, but what should children of about ten to fourteen years of age, for example, learn, and how?

A second common proposal for meeting the current problems is to develop a wider range of instructional materials, including new kinds of printed materials, motion pictures, tapes and records, new types of laboratory equipment and the like. This audience is so involved in these developments that the proposal does not need to be mentioned here.

A third proposal is to develop team teaching. Team teaching is an effort to answer several problems at once. It involves assigning to several staff members in the school (the team) the responsibility for a number of children who would in the typical school be distributed among several classrooms. For example, the team may have responsibility in the primary grades for a hundred children who are in their first, second or third year of school. The team might be composed of four people, one an experienced and very competent teacher, another an intern teacher, and others with special competencies of various sorts. This team will plan the strategy for the education of these primary children and also will be able to utilize the special talents of each team member in carrying out specific parts of the program. Team teaching attacks the teacher shortage by enabling apprentice teachers to be used and by utilizing, when appropriate, some people who have no usual teaching skills but can handle some of the more routine aspects of the school, such as helping children with their wraps, keeping records and the like. Team teaching also permits teachers with special talents to bring their talents to bear on many more children than those in a simple classroom. Team teaching permits greater flexibility in teaching for it is possible at some times to work in small groups, sometimes in large groups, sometimes individually, and to move youngsters from one group to another in terms of their own readiness for learning a particular thing.

A fourth proposal is to give much greater emphasis to individual pupils progressing at different rates and using different materials as they move along. This is often linked with team teaching. For example, in the previous illustration of the primary grades where there are team teachers, some of those youngsters move through the primary in two, two and a half, three and a half or four years while the typical time would be three years. By giving attention to individuals, the situation permits variation in time, in assignments, in materials. An attempt is made to provide more varied opportunities for youngsters to be challenged, to be helped, to progress at different rates and not to have the sense of failure if each grade is not completed in one year.

A fifth proposal for meeting the problems is to develop learning laboratories which will make independent work more feasible. These laboratories in such fields as reading, mathematics, language, science and social studies are planned as places to experiment with independent work on the part of children and youth. The conception of these learning laboratories is to include in each laboratory all the materials and equipment relevant to the learning in that field which are practicable to purchase and to use. This means not only books, pamphlets, records, tapes, film strips, motion pictures, but also self-testing materials and equipment, the so-called "teaching machines," or better, "learning machines." The emphasis in these laboratories is upon independent work, self-teaching and self-testing.

A sixth proposal in meeting the current educational problem is to use much more extensively TV presentations and/or completely filmed courses. The investigations of educational TV courses are numerous and several studies have been made of the learning of students who used the White physics films, a complete course on motion picture films. In Nebraska, for example, where there are many small high schools without a science teacher, the White films have been used. In one small high school the principal told the senior boys that they had a unique opportunity to learn from one of the best physics teachers in the country if they wanted to use the films, but he couldn't help them since he knew little about physics. The boys, challenged that way, saw all the films, worked up some simple laboratory things for themselves that they could use, although they had nobody to supervise them except for the occasional encouragement of the principal. They took the standardized examinations and not one of them failed. This kind of thing is increasingly possible in areas where teachers may not be available. In this case films were used but TV might serve the same purpose.

A seventh proposal to deal with the school's problems is to build more flexible structures. A box-like building with a number of similar rooms holding thirty-five to forty children is inappropriate to provide for the varying groups and activities now contemplated. School buildings must be changed a good deal in order to provide for flexibility in assignment of youngsters, to furnish needed space for learning laboratories, and for the use of various kinds of media.

There are other proposals currently made but they seem to me somewhat less clear than these seven which are already on the drawing board and some of which are actually in use. I feel sure that we can count on these kinds of developments during the next twenty years.

THE SHADOW OF NEW MEDIA ON THE CLASSROOM

By Roy M. Hall

Dr. Hall is Assistant Commissioner for Research in the U.S. Office of Education. He points out here that the shadow of the new instructional devices falls on the classroom in four important patterns.

Television and other educational media are influencing some positive and observable changes in schools and classrooms. Fortunately, these changes are not rapid. Neither are they entirely a consequence of new media. As desirable as these trends are, they need to evolve with careful planning and a continuous sensitivity to the need to enhance both learning and teaching.

One of the expected changes in classrooms and schools in the immediate future is a more widely dispersed classroom and educational program than at present. This idea is by no means new. The tutorial system once widely practiced in Europe was not implanted in American education because there were no libraries and too few textbooks and informed teachers. Students were assembled simply to give them access to a book or set of references or to learn directly from the instructor.

Several factors emerging on the socio-economic scene make possible and even encourage a partial return to a modified tutorial system. Parents, employers and their supervisors, and civic leaders are more active in educational affairs, have more time to work with learners and are more highly educated in their respective fields. It is natural, therefore, that education call into full play these factors and couple them with television and other media to provide educational experiences in the most appropriate physical, psychological, and economic learning environments.

What are some of the learnings appropriate for dispersal to richer environments? What are some of the environments which the dispersal of the classroom may effectively utilize? The home and family activities, resources and contacts lend themselves to the learning of health, civics, home economics, and perhaps languages. If courses of study are revised and curricular materials developed around such activities, resources, and contacts, the teaching of these subjects by television, films, recordings, etc. may well involve the home and community as the central learning arena.

Studies bearing on intellectual development and academic achievement have consistently pointed to the home and family background as a prime factor. Furthermore, sociologists have been eagerly seeking a dynamic with which to restructure and stabilize parent-child relations.

Likewise, such subjects as bookkeeping, typing, interior decorating, filing, and many shop courses may be taught in offices, stores, and factories. This type of classroom dispersal, too, meets other long-felt needs: the desire of business and industry to be more active in the development of vocational education, simultaneously leaving schools freer to provide liberal education to all students.

Present research and thinking indicate, therefore, that the new media may become a realistic facilitator of some innovations in education long needed but only now made possible. In short, with modern means of communicating knowledge, information and instruction generally, many school subjects may be more effectively handled in their natural environment.

Second, the classroom and school is already becoming, as a direct consequence of media application to educational procedures, an open window through which the learner views the world and all its phenomena. We have too often assembled students in the classroom and closed the doors to teach them about people, things, and events throughout the world. Now, however, it is possible to transmit into the classroom or school and community auditorium, through all kinds of media, experiences from every realm of life. Thus the classroom is no longer necessarily a closed environment, but a window through which the learner looks at, listens to, and actually experiences the evolution of the world.

It has been difficult in the past to provide students with objective learning experiences in social, political, economic, scientific and cultural developments as they take place. Field trips, visiting lecturers, traveling demonstrations, science fairs, and many other techniques have been tried. Most of these create administrative problems and are too often unrelated to pre- and post-classroom work to be effective. With films and television a science class can watch and even study the development of new fuels and their uses in space travel; a social science class can even simulate a Congressional hearing or the passage of a law or a summit meeting and all its requisite preparation; students of economics are able to experience the developments in Africa, Hawaii, and Canada.

This potential for enriching the classroom is accompanied, however, with some realistic problems which must be dealt with thoroughly or these potentials for good may become evils. The projection into a classroom of able young students the latest developments in electronics, chemistry, astronomy and all the concomitant knowledge inherent in the success or failure of satellite launching from Cape Canaveral may be a real threat to a science teacher who at best has only a smattering of knowledge in all the fields of science involved. More recently and thoroughly prepared teachers are essential. Perhaps, teams of teachers with each team member playing his appropriate role is the answer.

Furthermore, capitalizing on these possibilities is contingent upon innovations in materials, guides, schedules, units of study, and a wide range of other factors.

It is well that we look at not just what is possible, but also at how to introduce these changes into our schools and colleges so as to guarantee the greatest possible benefit and the least possible confusion to our schools and colleges and their faculties.

Still another change already evolving from research on the use of combinations of media and classroom methods is that both teachers and students are playing more appropriate roles in various phases of the learning situation. Consequently, the teacher, parent, administrator and students are developing a more positive and dynamic relationship in school programs. A great deal of the routine drill and testing can be self-directed by students themselves. Guided study and home projects, stimulated by television, recordings, and even films, becomes a parent shared responsibility.

The teacher or team of teachers plan the demonstrations and counseling, lead students in selecting and arranging material, illustrations, individual projects and self-study programs. The teacher becomes the planner, leader, and counselor. Indeed, the teacher is rendered capable of being the scholarly diagnostician and stimulator by being relieved of many of the present time-consuming lectures, drills, tests, management duties, and routines.

Capitalizing on this possibility is also contingent upon a complete reorganization of the school and a reorientation of teacher preparation programs.

Finally, the research and development going on in the production of films, studio teaching, and programming for teaching devices clearly portray a new emphasis on ordering knowledge, establishing sequence, and clarifying process. The teacher will spend more time studying bodies of knowledge, defining concepts, and translating these into sequences and forms appropriate to the learner and the means of mediation.

Here, too, teams of teachers are likely to be working with various groupings of students. Such activities are already under way in the Math Study at Yale, the Biology program at Boulder, and the Science and Math programs at the University High School in Urbana.

It is obvious that when the subject matter specialists, master teacher, counselor, and audio-visual expert work together to order and sequentialize the concepts to be taught and translate them into forms or media, and then arrange together a program appropriate to the learner's needs, all argument about the relative significance of content and process becomes irrelevant. In this type of education they are both absolutely essential.

OLD AND NEW TEACHING AIDS

By William E. Spaulding

Mr. Spaulding is President of the Houghton Mifflin Company, and a former President of the American Textbook Publishers Institute. He points out that the textbook is the oldest teaching aid and the first bit of automation to enter the classroom, and outlines some of the research in teaching aids textbook publishers and authors would like to see done.

The textbook affords an excellent point of reference in any discussion of the new media in education and their potential. For the textbook is our oldest teaching aid; many consider it still our greatest visual aid; and it is unquestionably the first and most far reaching bit of automation to enter the classroom. We are excited by the fact that television makes it possible to multiply indefinitely the student audience of the superior teacher. But the textbook with its printed speech and illustrations has permitted every classroom in the nation to take advantage of a superior teacher, of his instructional language, of the visual aids he has found most effective in his teaching, of his experience with systems of teaching and learning, of his sincerity, his enthusiasm, and his inspiration. It brings the superior teacher not only to the classroom but individually to every student in the classroom as television has not yet been able to do. The student can take his superior teacher in print home with him in his hand or in his pocket; he can consult him and listen to what he has to say and look at his pictures in his own time whenever he pleases and as often as he pleases.

Self-teaching textbooks and the better type of workbooks -- those which are more than drill and practice books or so-called "busy work" or "seat work" -- are as surely "tutoring devices" as are any of the new teaching machines. The machine has succeeded in focusing attention clearly and specifically on the same sort of precision and reinforcement in independent learning that the self-teaching workbooks and textbooks have long been attempting with varying degrees of success.

But my purpose here is not to argue the case for the textbook nor to belittle in any sense the newer media of teaching and learning. On the contrary, I would only stress the point that they all hold great promise for improving the quality of education -- and that is what each of them must do if it is to justify its continued existence.

No one knows this better than the publisher of textbooks. He is in a highly competitive business and he quickly learns that the continued success of any piece of educational material, whether it be textbook, workbook, test, record, film, or what not, depends on how well it does the educational job it was designed to do.

Because he knows that he must build on genuine merit, no publisher in his right mind is going to spend the hundreds of thousands of dollars that it costs to launch a new series of books unless he is convinced that those books are going to make some very important contributions indeed to teaching and learning. They must have something to offer that is not already offered by their competitors. Inevitably, therefore, the textbook publisher must be constantly in search of new and better ways of teaching, of new and better ways of presenting and organizing subject matter. No one is more sensitive than he to the need for modification and change in his product. No one is more concerned to discover just what role that product can most successfully play in the classroom of today or of the future.

Technological change and the new educational media will undoubtedly call for change and modification in printed materials of instruction. The publisher knows this. He is prepared for it. He lives on change and modification. Because of his complete and unshakeable confidence in a major, an essential, and a permanent role for the printed word in the pattern of teaching and learning he welcomes rather than fears the technological developments that have introduced the new educational media we are considering here.

He welcomes them because they are inevitably spotlighting an area of major interest to the textbook publisher. They are forcing a rigorous and thoroughgoing re-appraisal of what leads to more successful learning and better teaching in the school. The sponsors of new devices must find answers to the same questions that textbook authors and editors have been asking for years. What should be taught? Where should it be taught? How should it be taught? Who is the learner? What is his background of experience? How does he learn? And finally, what are the peculiar or unique teaching and learning advantages of this particular medium and what are its limitations?

We have had all too little research in the past looking toward answers to these questions and almost none that could be confidently applied to printed materials of instruction. Publishers have not had the resources that would permit them as a group to underwrite any significant amount of competent research. Individually they have had to rely largely for their answers on the experience of authors and editors, on common sense and creative imagination, and on the more or less sporadic tryout and testing of materials in manuscript or in proof. They will continue to use these methods for the modification and improvement of printed materials of instruction, but in the critical period in education in which we find ourselves and in the need for adaptation to the new media a much more reliable scientific basis for the development, not alone of printed materials, but of all media of instruction, is imperative.

There are three broad areas in which basic, underlying research is sorely needed if we are to make the most of the opportunities which our present broad array of teaching media afford us:

The first and the most nearly basic would concern itself with the laws of learning and child development. But it should not be limited to general principles which may or may not be applicable to media programs. We need to know much more than we know now about the specific audience or audiences which our teaching media are designed to reach. We can make our communication effective only if we know a great deal about the background, interests, and learning capacities of boys and girls at all grade levels. And we need to know a great deal about the subject matter that can and should be taught at varying grade levels and about the techniques that are best suited to the teaching of a specific subject at a specific time to a specific audience.

The second area would be concerned with the media of teaching. Can we determine the essential and unique role of each one of them? What are the peculiar advantages in independent learning that are afforded by books and other printed materials of instruction as contrasted with other media? What are their limitations? What do they and what can they contribute to the guidance and training of teachers? Where and how can so-called teaching machines make their greatest contribution? What can they do best; what should they not try to do at all? Are there basic techniques which should guide everyone who attempts to "program" for the machine? And so on with teaching films, film strips, tapes and recordings. I leave television until the last because it is the "general" medium which can, at least theoretically, combine and present many, if not all, of the others. What is the permanence of television learning? How can we best capitalize on the advantages of the medium -- its ability to show on the screen anything, anyone, anywhere almost without limitation in time or space. How much more effective is the carefully planned, edited, and reviewed master teaching film on television than the best that the superior teacher can offer more or less impromptu? Is it worth its cost? Should television undertake to do more "group" teaching than has been done in the past by our best "live" teachers? What, in short, is the unique role that television can play in the total pattern of teaching and learning? What should it not expect or try to do?

The third area is the most important of the three in one sense, yet it inevitably draws largely on the other two for its data. It is concerned with the most effective ways of using all the media in various combinations. And here again we need more than general principles. What combination, for instance, of verbal statement and pictorial aid will best accomplish a particular teaching job at a particular grade level in a particular subject? Is the verbal statement better made in oral or in printed form? How can one medium best reinforce another? In any combination of media, what is the role and what are the responsibilities of the live teacher? What does pupil participation through teacher guided discussions contribute to learning in particular situations? Are there social and competitive values in the present classroom group that are lost with proposed "dispersal" of the classroom? How important are they? And so on, indefinitely.

However much or little of research may be possible and practicable in these three areas, I am sure that I speak for the textbook publisher when I say that he is vitally interested in all three -- in the general problem of teaching and learning, in the unique individual roles of the various media, including printed materials of instruction, and in the most effective combination or combinations of all media. He is not only interested but he is also ready and willing to contribute anything he can from his experience to the planning and analysis of the research to be undertaken.

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II

RESEARCH BACKGROUND

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LEARNING THEORY AND ITS APPLICATIONS

By Ernest R. Hilgard

Dr. Hilgard is Professor of Psychology at Stanford, a former President of the American Psychological Association, and author of the well known Theories of Learning. Here he briefly sums up the present state of learning theory, and discusses the problem of applying it to the development and improvement of teaching aids.

When I prepared the first edition of my Theories of Learning (1948) the major viewpoints in learning theory were well characterized by the names of those who sponsored systematic theories: Thorndike, Guthrie, Hull, Skinner, Tolman, Köhler and the rest. While one can still grope his way among the theories of learning by studying the major theorists, the situation has changed rather drastically in the last ten years. While in the second edition of my book (1956) I continued some of the chapters with the big names, new chapters had to be added to encompass other kinds of developments, such as the new mathematical models.

Recent theoretical writing on learning shows little of the major line-up for a debate, as was formerly the case between students of Hull and Tolman. Instead there are enough problems within any one of the theoretical positions to keep the theorist busy close to home, without sallying forth to conquer discordant and alien systems. Many of the old issues turned out to be spurious ones, not crucial as between theories. Latent learning, for example, once seemed to be an issue that if settled one way would favor Tolman's theory, if settled another way would favor Hull's. Now everybody accepts latent learning, but the conditions under which it is found and not found are complex enough to put all theories under strain, and the facts favor one theory no more than the other. As Logan has recently put it (1959, page 335): "There is no question but that such latent learning phenomena have forced a more detailed elaboration of the S-R reinforcement theory. It appears to this writer that what were taken as fundamental differences between learning theories are becoming markedly attenuated as such elaborations are made."

The contemporary complications within each theory are many. For example, consider the distinction between learning and performance, an important distinction first made by Lashley, then picked up by Tolman, and later formalized by Hull. Hull put this into his basic formula in which reaction potential (E), corresponding to performance, is a product of habit strength (H) and drive (D). The distinction between habit and drive, which at first seems very clear, has become a real theoretical morass. For example, drive functions are now assigned by S-R psychologists to anticipatory responses, to frustration, and even to the anticipation of frustration. Obviously there can be no sharp distinction between drive and learning if learned responses have drive significance.

For some reason that will one day interest the historian of science, learning experiments carried out in the tradition of Gestalt psychology or of Tolman's sign learning theory have all but disappeared. This does not mean that there has been a general verdict against these theories. I believe that there may be two reasons for the neglect of these viewpoints: first, many of the problems that cognitive theorists raised when objecting to S-R theories have been taken over as problems within S-R theory; second, no cognitive theorist has come along to play the role Hull played for S-R theory, that is, to reduce it from its programmatic stage to a level of precision that invited quantitative experiment and interrelated steps in theoretical deductions. The fact that nobody has done this does not mean that it cannot be done; there were thirty years between Thorndike's S-R theory and Hull's first attempts at rigorous systematization. It is now almost thirty years since Tolman's purposive behaviorism came to prominence. If the theory is to be salvaged, it is indeed high time for someone to work on it.

Before returning again to some developments within learning theory, let me stop for a moment to say something about the relationship between learning theory and school practices. A year or so ago I participated in a symposium at Northwestern University on the topic: "Can the laws of learning be applied in the classroom?" The major presentations were given by Kenneth Spence, Arthur Melton, and Benton Underwood, three leading theorists and experimenters in the psychology of learning as defined by experimental psychologists. Their papers have since been published (1959). I found the symposium at once heartening and discouraging: heartening because it represented a serious attempt of experimental and educational psychologists to "get together"; discouraging because the present bridges between the laboratory and classroom are so flimsy. Therefore, after saying something further about learning theory, as such, I wish to indicate some of the steps, as I see them, for making a more valid application of the psychology of learning to the classroom.

DEVELOPMENTS WITHIN LEARNING THEORY

In describing developments within learning theory it is fortunate that there are several excellent sources on which to draw. There is the large book called "Modern learning theory" prepared by Estes and others (1954) which attempts to take the major theories apart in much more detailed fashion than I have attempted in my book. Then there are the volumes of the Annual Review of Psychology in which some excellent chapters by leading authorities have given their estimates of the state of the art so far as learning is concerned. Finally, the second volume of Psychology: A study of a science, edited by Koch (1959) contains highly competent summaries. Let me call the roll of these, because I will not have time to consider each of them: Lewinian theory (by Cartwright), Tolman's theory (by Tolman), Guthrie's theory (by Guthrie, just before his death), liberalization of S-R Concepts (by Neal E. Miller), the Hull-Spence approach (by Logan), Skinner (by Skinner), the statistical approach to learning theory (by Estes), learning set and error factor theory (by Harlow), rote learning (by Irion). The first volume contained chapters on Köhler and on Egon Brunswik. These are evidently rich sources for a contemporary picture of learning theory.

At the risk of being quite superficial, let me indicate a few of the signs of "what's new" in terms of these latest chapters on learning:

1. Tolman, in what must remain the last statement of his theory, showed a bit of influence from the MacCorquodale and Meehl attempt (1954) to formalize his system. He was also a little more ready than earlier to admit the empirical Law of Effect, but he continued to insist that his position differed from that of the S-R psychologists.

2. Guthrie, in what is also the final statement of his position, found room for some considerations he had earlier neglected. He incorporated something very like the Muenzinger-Tolman "vicarious-trial-and-error" (VTE). That is, he recognized an active scanning before action was initiated. "The situation is scanned for familiar features. When a familiar pattern is discovered, the response last following that pattern will be evoked" (page 168). He also noted the importance of attention, and a new statement of his basic law of association becomes: "What is being noticed becomes a signal for what is being done" (page 186).

3. Neal Miller's S-R theory is really an input-output theory, and a stimulus can be any antecedent and a response any consequent. Thus it is a functionalism or a connectionism, correctly in the tradition of Thorndike and Woodworth, who were the original S-R psychologists.

The developments under Miller (along with Dollard) are highly original, and it is a good thing to have this chapter where one can follow Miller for himself, and dissociate him from the Hull tradition to which he is really only tangentially related.

4. The Hull-Spence chapter by Logan is an excellent one, pointing up the similarities and differences between Hull and Spence, and modestly introducing Logan's own conception of the micromolar level of analysis. This new outlook, which Logan is developing as his contribution to learning theory, suggests that responses of different force, rate, or intensity, are different responses, and the learning of which of these responses to give is an important determiner of the course of learning. The emphasis is, in fact, a natural extension of the distinction that Skinner has made all along between discrimination of stimuli and differentiation of responses. Logan announced his position in 1956, but he has been developing it since, and we expect to hear more from him.

5. Estes' chapter on the statistical approach to learning theory is a gem. He thinks clearly, knows what he is talking about, and has convincing evidence to show that what he says is worth attending to. Some important new developments appear in this chapter, such as the prediction of time-dependent processes. These involve a model in which the basic parameter fluctuates, leading to interesting consequences. The elegance of this approach, and the degree of success achieved since 1950, mean that it must be taken seriously.

6. Harlow is trying to take his place among proponents of major learning theories by advocating his form of uniprocess learning theory (Harlow and Hicks, 1957). This uniprocess is inhibition: learning is nothing more than the elimination of responses and response tendencies inappropriate to a particular learning situation. This theory appears to me to be unusually forced; as in the case of most such theories, the proponent looks around for the cases that fit it best, without looking for those where it might not be appropriate. To be sure to put a key into a keyhole means to inhibit doing a lot of things one might do with a key, such as throwing it out the window. I would turn the explanation around: The best way to inhibit doing the wrong things with the key is to know the right thing to do with it. Thus there is competition, but to leave the right act as a mere residue after wrong acts are eliminated is to play a strange game with response possibilities.

This particular volume does not deal in any important way with the new developments in the physiological correlates of learning, a deficiency made up by other volumes, such as the 1956 proceedings of the Association for Research in Nervous and Mental Diseases entitled The Brain and Human Behavior, and the symposium edited by Harlow and Woolsey called Biological and Biochemical Bases of Behavior (1958). The new leads on the physiology and neurology of learning include the new emphasis upon the ascending reticular activating system (ARAS), upon the role of efferent processes in modulating afferent input, the so-called "gating" mechanisms, the consequences for learning of brain stimulation in the various parts of the visceral brain or limbic system, as well as neurochemical theories. While these leads are exciting, I do not see that any one of them makes any difference thus far in what we should do in the classroom.

SOME SUBSTANTIVE FINDINGS SUITABLE FOR APPLICATION

The preceding review of developments within learning theory was intended to point out that the field is still active, and its problems are unsettled. There is not yet a consensus on the so-called "laws of learning". This means that work needs to continue, in the spirit of pure science, to put the field into systematic order.

At the same time it is reasonably clear that the main trends of earlier findings on learning have not been upset by more recent findings and there is a residue of useful principles that can be kept as reminders when practical applications of learning are under consideration. I earlier presented a list of 14 principles that I felt would be widely agreed upon (Hilgard, 1956, pages 486-487). I wish now to present a somewhat similar list, but differently classified. It is possible to propose a number of principles that have all along been prominent in S-R theory, a second set suggested by cognitive theory, and a third set coming from the study of personality. I believe these principles to be in large part acceptable to all parties, and the affiliation with one or another source is a matter of emphasis rather than of controversy.

A. Principles emphasized within S-R theory

1. The learner should be active, rather than a passive listener or viewer. The S-R theory emphasizes the significance of the learner's responses, and "learning by doing" is still an acceptable slogan.

2. Frequency of repetition is still important in acquiring skill, and in bringing enough overlearning to guarantee retention. One does not learn to type, or play the piano, or to speak a foreign language, without some repetitive practice.

3. Reinforcement is important; that is, repetition should be under arrangements in which correct responses are rewarded. While there are some lingering questions over details, it is generally found that positive reinforcements (rewards) are to be preferred to negative reinforcements (punishments).

4. Generalization and discrimination suggest the importance of practice in varied contexts, so that learning will become (or remain) appropriate to a wider (or more restricted) range of stimuli.

5. *Conflicts* attendant upon generalization and discrimination have consequences that may be unintended by the person attempting to manage the learning. Many of these consequences, as studied by Neal Miller, are of the kind that interest students of psychopathology.

6. *Drive* conditions are important in learning, but all personal-social motives do not conform to the drive interpretations of Hull and Spence. Anxiety, as measured by the Taylor scale, appears to act as a drive should, but achievement motivation apparently does not (Farber, 1955).

B. Principles emphasized within cognitive theory

1. A learning problem should be so structured and presented that the essential relationships are open to the inspection of the learner. Thus *perceptual aspects* of the problem (figure-ground relations, directional signs, "what-leads-to-what") represent important features.

2. The direction from simple to complex is *not* from arbitrary, meaningless parts to meaningful wholes, but instead from *simplified* wholes to *more complex* wholes. This suggests that we need to study the psychological organization of knowledge, and should not deal mechanically with the part-whole problem.

3. Learning with *understanding* is more permanent and more transferable than rote learning or learning by formula. This generalization gives point to the similar emphasis within S-R theory on meaningfulness as a factor making for ease of acquisition and recall.

4. *Cognitive feedback* establishes probabilities and (in some cases at least) is an appropriate explanation of effective reinforcement. The corresponding S-R principle is that of knowledge of results. The notion is that the learner tries something provisionally, and confirms his attempt by its consequences.

5. *Goal-setting* by the learner is important as motivation for learning, and his successes and failures are determiners of how he sets his future goals. The attempt to reduce cognitive dissonance (Festinger, 1957) leads to many kinds of maneuvers *after* the results are in.

It will be noted that this list from the cognitive position is somewhat harder to specify than that from S-R theory, and the points, while plausible, lack systematic proof. It was earlier remarked that this lack of working out of cognitive learning theory does not mean that the theory has nothing to offer.

C. Principles from personality theory

Whenever one considers the arts of practice it is not possible to preserve the neat compartments of knowledge permitted the investigator in the laboratory. Some of the following principles, little emphasized within the psychology of learning, are important background factors for school learning.

1. The learner's *abilities* are important, and provisions have to be made for the slower and more rapid learners.

2. Some abilities are a matter of physiological and social development and knowledge of development should be related to the demands made on the learner. Some such knowledge may turn out to be very important, e.g., in the teaching of reading and spelling.

3. Personality is a social product. Hence it is important to be aware of the culture and subculture as they are relevant to what and how the learner can learn.

4. Anxiety level, especially the "test anxiety" of Mandler and Sarason (1952) appears important in determining the beneficial (or detrimental) influence of praise and blame. The generalization appears justified that with some kinds of tasks high-anxious learners perform better if not reminded as to how well (or poorly) they are doing, while low-anxious learners do better if they are interrupted with comments on their progress.

5. The same objective situation may tap appropriate motives of one learner and not of another. The contrast, for example, between those high in achievement motivation and those high in affiliation motivation has been reported by Elizabeth G. French (1958).

6. The organization of motives and values in the individual is relevant. Some long-range goals affect short-range activities. For example, college students of equal ability may do better in courses perceived as relative to their majors than in those perceived as irrelevant.

7. The group atmosphere of learning (competition vs. cooperation, authoritarianism vs. democracy, individual isolation vs. group identification) will affect satisfaction in learning as well as the products of learning.

A THEORY OF APPLICATION

The strong emphasis these days upon the importance of pure science is an attempt to restore balance, but it must not be permitted to degrade the importance of applied science. The applications of science require the same high order of abilities, and the same concern for objectivity, that characterizes pure science. Three considerations apply as one thinks of the relation between pure and applied science:

1. Pure science does not lead automatically to its own applications. A stage of invention lies between. Consider, for example, the development of prestressed concrete, now widely used in bridge building. The principle that concrete could stand enormous pressure but had low tensile strength was well known; the corresponding principle that a steel cable has high tensile strength but is not useful as a column was also familiar. It was the combination of these two things -- the high compression strength of concrete and the high tensile strength of steel -- that resulted in a significant new technological development. The insight involved is essentially that a beam can be conceived as a column turned on its side: reinforced concrete columns heretofore did not crack, while reinforced concrete beams did. Now the beams (under stress) do not crack.

2. Technology does not have to wait for pure science, but may be ahead of pure science. The history of science and technology makes it clear that our practical

knowledge of diet, of poisons, of metallurgy, of fertilizers, of animal breeding, all were far ahead of the pure science at the time these practices developed. If the pure science of learning is still somewhat underdeveloped, this does not prevent important advances in the technology of education.

3. The advance of knowledge through the interplay of pure science and technology is a two-way process: pure science can get leads from successful technological inventions, just as technology can profit from principles coming from pure science. We need to maintain not only a division of labor, but free flow of two-way communication, and an equitable distribution of prestige between those who work in pure science and in the fields of application.

With some such general considerations in the background, I wish now to make some proposals for a rapprochement between the psychology of learning and educational practices. These suggestions lean in part upon, and are not contradictory to, those proposals made by Melton (1959) in the Northwestern symposium to which I referred earlier.

1. A taxonomy of learning as it applies to the classroom would prove useful. If we knew our task better, we might better know how to achieve it. For example, we are up against questions such as these: What kinds of teaching can best be done by teaching machines? What is the most effective contribution of the classroom teacher? of the specialist? What unique services have the library, the laboratory, the studio, the shop, the field trip? How do we teach curiosity, search, initiative, inventiveness? A start has been made by Bloom (1956) who provides a taxonomy of educational objectives. We need a taxonomy of processes to mesh with such a list as his.

2. Beyond research on principles of learning we need research on the bridges between theory and practice (that is, on what has come to be known as *developmental research*) and then we need research at the point of application (what Melton refers to as *operational evaluation*). In some sense we need a revival, with a sounder research base, of what was formerly called "the psychology of special school subjects."

3. *Educational research is a problem in applied social psychology as well as a problem in the psychology of learning*. In order to have a scientifically grounded education we need to have changes, and we need to have these changes accepted by those who will have to use them. Among the consumers of these changes are not only the pupils, but their teachers, administrative officers, school boards, and parents (not to mention taxpayers). Hence effective educational research requires a strategy of participation and decision-making so that proven results will become a part of practice. This is a more difficult point than it at first appears to be, but it must be considered early in the design of any kind of experimentation that is likely to lead to changes in facilities or practices. The two main points, as I see them are (1) to involve the teacher in the research as a responsible member of the research team, and (2) to involve representatives of the community early enough so that they are committed to make the changes dictated by the results of the research.

Thus I have turned the topic somewhat from what needs to be done to improve the state of learning theory to what needs to be done to improve our theory of how we are to use the knowledge of learning in the classroom.

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SOCIOLOGICAL PERSPECTIVES ON THE USE OF NEW EDUCATIONAL MEDIA

By John W. Riley, Jr., and Matilda White Riley

Dr. Riley is Chairman of the Department of Sociology at Rutgers. Matilda Riley is Mrs. John W. Riley, Jr., a sociologist, and Executive Officer of the American Sociological Society. In this paper they discuss the classroom and its activities as part of a social system, and treat some of the problems of introducing such innovations as new teaching aids into the system.

1. Need to Study Social Systems in Which Innovations Occur

Behavioral scientists would generally take it for granted that such basic phenomena as teaching and learning cannot be adequately understood without some specific reference to the social situations within which such processes take place. When we consider the introduction of new media in education, we are, in this view, raising a host of questions as to the consequences of such innovations not only for teaching-learning as an isolated phenomenon, but also for the various actors in the social setting in which the phenomenon occurs, including students, teachers, families, peer groups, school officials, members of the community at large, and the like. Furthermore, we are asking how such consequences in turn *react* upon the teaching-learning phenomenon itself. That is, if we want to study educational innovation (as this might occur via such new media as television, radio, films, slides, laboratory demonstrations, recording instruments, "talking" workbooks, learning machines, and the like), we must give some attention to the nature of the social system of which the educational process[1] is a component part.

Any model of a social system has a number of essential characteristics, and the outlines of a general model are gradually being specified through study and experimentation in a wide variety of social situations and fields of application. Central among the characteristics of such a model is the principle that the parts of the system are all interdependent with one another. Thus any slight disturbance introduced into the system will have ramifications throughout the whole, and will be counteracted by various reactions tending to restore the state of equilibrium. This means that any contemplated innovation must be viewed as potentially affected by, and in turn affecting, all the other parts of the system.

In order to illustrate a sociological approach to the study of possible innovations in the educational system, we shall suggest how one social system model, now in use at Rutgers, might be adapted and applied. This particular model was developed for studying the mass communications process (39), but it may also be specified to deal particularly with the notion of education as a series of communications between teacher and student.[2]

Formal and informal systems

A social system model usually distinguishes between the "formal" and the "informal" aspects of the system.[3] For many important fields of sociological analysis -- notably business and industrial organizations, the military establishment, and both public and private hospitals -- this distinction has been productive of much new knowledge.

As applied to the educational system, the formal aspect might be thought of as consisting of the manifest organization which includes hierarchical arrangements of service personnel, students, teachers, supervisors, principals, superintendents, board members, and so on. Each status carries its own responsibilities and perquisites and, at the same time, assumes a degree of competence which can be clearly defined with reference to the requirements of other statuses. Such a formal organization has a characteristically bureaucratic structure (13-198) and this, according to Max Weber, involves "a clear-cut division of integrated activities." (31-196)

The goals of such a formal system are also stated, although not always explicitly, in terms which involve the codification and transmission of the existing culture to each new generation. In this sense, the goals are essentially conservative. As Robin Williams has put it,

> "The cultural heritage must be renewed for each generation; society is daily invaded by new 'barbarians' who have to learn thousands of specific skills, beliefs, knowledges, values, and norms if the culture is to have any continuity." (48-260)

While little consensus would perhaps be found on the specific aims of education -- liberal vs. "practical," general vs. specialized, "adjustment" vs. achievement -- there seems to be general agreement on the central objective. This objective, stated in sociological terms, is to train people for the performance of adult roles. While formal statements of such an objective may vary for elementary schools and institutions of higher learning, they usually contain two basic "ingredients," as Talcott Parsons has recently pointed out. (33) First, students are expected to make certain "commitments" to broad social values, so that the educational process may train a person to develop a commitment to hard work in his future occupational role, for example. Second, students are expected to develop "capacities" for the carrying out of specific role assignments which require both specific knowledge and skills and a sense of role responsibility.

Underlying such a formal educational system, and closely interdependent with it, is a vast network of families, peer groups, voluntary associations, and the like, in which both teacher and student play significant roles. Thus each brings to the classroom his special background of personal and social experiences. And each one acts in the classroom, not uniquely in his formal role, but also partly with reference to these other groups to which he belongs. As Schramm makes this point,

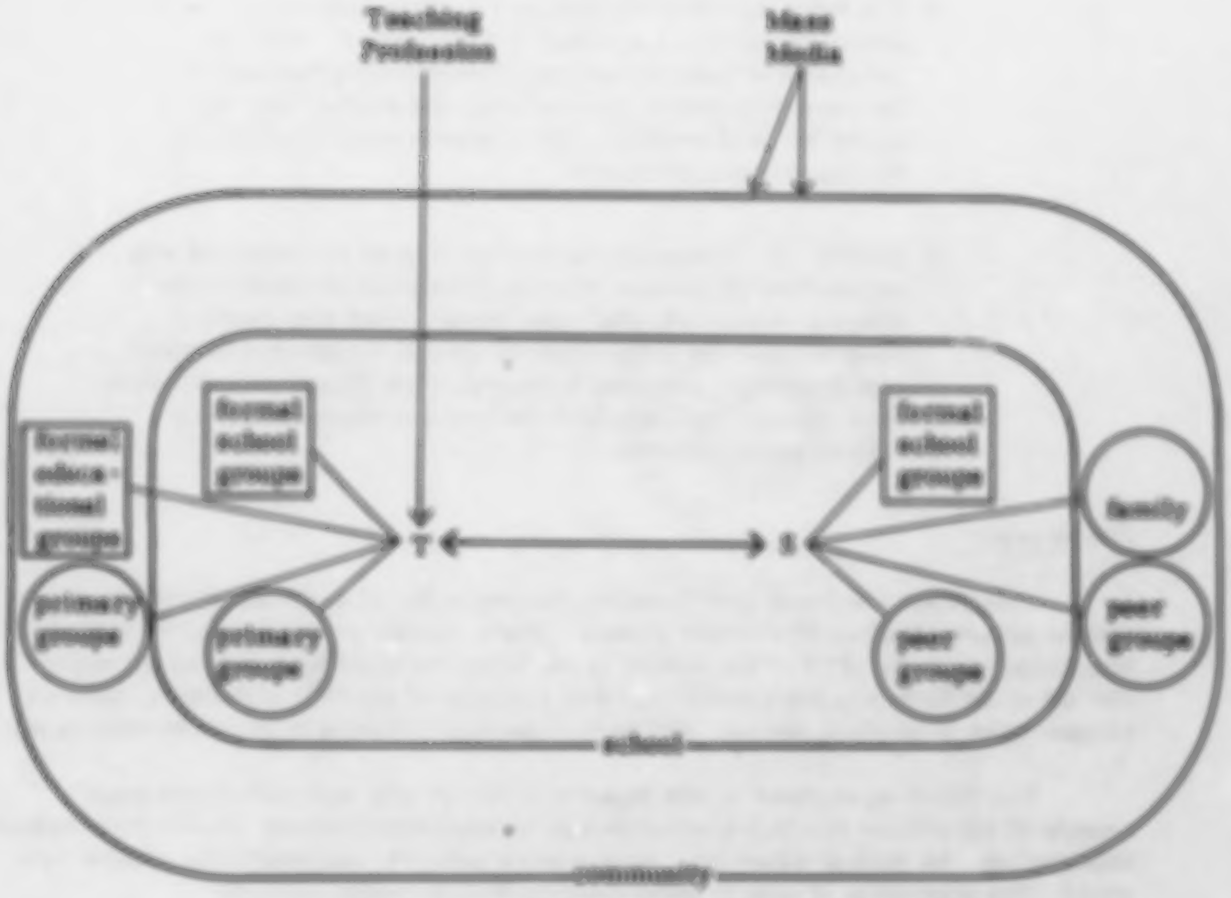
> "...if [his] groups do not sanction the response [he is] inclined to make...then [he is] very unlikely to make it. On the other hand, if [his] group strongly approves of a certain kind of action, that is the one [he is] likely to select out of several otherwise even choices." (43-15)

Thus his motivation to perform as a teacher or a student depends in part on the expectations -- the fear of disapproval or the hope of approval -- of these others. Each individual acts, perceives, feels, thinks in different ways depending upon his relationship to significant others both in the formal and in the informal networks to which he belongs.

Diagram of a possible model

A schematic view of such a working model is suggested in Figure A:

Figure A. Diagram of an Educational System


Teaching Profession
Mass Media
formal educational groups
formal school groups
primary groups
primary groups
T
S
formal school groups
family
peer groups
peer groups
school
community

1) At the center of the system is the interactive relationship between T (the teacher) and S (the student), as the teacher communicates knowledge and the student responds (through the class discussion, examinations, and so on).

2) A boundary encloses this interactive relationship to represent the formal system of the school itself.

3) Within this boundary S is connected with primary groups of other students, and T with primary groups of teachers and staff members -- primary groups with which each individual interacts, which shape his values, sanction his behavior, and accordingly impinge upon his role within the formal system.

4) Outside the boundary of the school itself, both S and T belong to other primary groups: families and peer groups; and also to formal groups within the community school system such as the school board or the parent-teacher association.

5) The outer boundary represents the community which encompasses the networks attached to both T and S. Thus the associates of both teacher and student belong together in the same community, interact with one another directly or indirectly, and are thus interdependent parts of an all embracing community system.

6) Outside the community the teacher is seen as connected with the teaching profession at large throughout the state or the country. Moreover, the mass media, since they serve in many respects to supplement the formal educational process (see Riesman), are seen to impinge upon the entire community from outside, reaching both teacher and student and their various social networks.

Plan of paper

This paper will focus upon possible changes in the educational process as these may be perceived within this larger system. While we may perhaps never be entirely able to grasp all the parts of the system at one time, we shall hold in mind the notion that all of the parts are interrelated and that a change of any kind in one part, such as an innovation in teaching method, will be in some way reflected in all of the other parts.

The following sections of this paper will deal in turn with each of the main aspects of the system in which innovation may be expected to occur: the teacher-student relationship, the student's network, the teacher's network, and finally the system as a whole. The discussion in each of these sections will be concerned with:

a) types of sociological insights and principles already at hand,[4] as suggested by research in various fields or implied by the model itself;

b) kinds of additional knowledge for which new research is needed.

2. The Teacher-Student Relationship

Types of innovations

Many of the proposed innovations will undoubtedly impinge directly upon the character of the relationship between the teacher and the individual student. Two dimensions along which change might occur seem particularly important in terms of their potential consequences, intended or unintended, for the effectiveness of the teaching process:

a) the relationship may be interactive (as in a discussion) or one-way (as in a TV program);

b) the relationship may be "expressive" in a friendly personal situation, or purely "instrumental" in a situation designed exclusively to impart knowledge or skills.

One-way vs. interactive relationships

There are many clues and insights available in the literature bearing on the possible use of a one-way medium, like radio or television, which limit the flow of "feedback" or response from the student audience. While the studies are loosely related to one another, and do not apply directly to the typical classroom situation, they do seem to agree in stressing the value of interaction, at least for some purposes.

On the one hand, there is some experimental evidence that the recipient is more apt to be influenced by a message when he is given a role as an active communicator himself. Lewin has demonstrated that group discussion may be more effective than one-way lectures in changing food habits. (29) Hovland reports a finding which might be interpreted to mean that persuasion is enhanced when the recipient participates, even indirectly, by handing on the message: as the researchers say, "When exposure...is held constant, individuals who are required to verbalize the communication aloud to others will tend to be more influenced than those who are passively exposed." (24-278) Other researchers shed further light on the interactive role of the recipient by describing his feelings in various small-group situations. Bavelas shows, for example, in task groups set up to communicate in writing through prescribed channels, that persons in relatively isolated positions are less satisfied with their roles than more centrally located persons. (2) A recent review of small-group research reports that "apparently one-way communication prevents not only expressive catharsis, but also the opportunity for building new understandings and norms by which the members manage their social relationships and their process of communication." (1-404)

On the other side, there is some indication that it may be functional for the communicator as well as for his relationship to the recipient if there is free flow of "feedback." Any communicator needs, of course, to know about the outcome of his previous messages. The teacher always receives some feedback through the system of examinations, but such response is highly specific and may not provide adequate understanding of the student response. Observations of small groups, such as street corner gangs or problem-solving groups in a laboratory, seem to imply that, if interaction is expected by the participants, there would seem to be a ceiling on the amount of participation by the leader of the group: the very considerable participation by the other members may serve to ease tensions and re-establish the equilibrium needed for close working relationships.

Such studies (quite apart from the wealth of experience within education itself with lectures vs. discussions) may well lead to innovations which call for the supplementation of new media with classroom discussions. Such innovations as they may affect the structure of the class will be discussed in Section 3, and as they may affect the prestige of the conventional teacher will be further discussed in Section 4 below.

Expressive vs. instrumental relationships

Sociologists, in analyzing the process of socialization, often make a distinction between instrumental and expressive relationships. In the instrumental learning situation, the teacher (or other socializing agent) merely imparts knowledge and skills; he is significant to the child primarily because he performs this specific function. In the expressive relationship the teacher or parent is a person to whom the child has general feelings of attachment. Thus he becomes a model for the child, who tends to take over his values, his standards of taste, his fundamental philosophical or ethical outlook. (33-111ff.) It will be noted that these two types of learning situations are parallel to the two ingredients of the educational objective as suggested in Section 1 above. This seems to imply that any innovation in the educational system would do well to attempt to strengthen both of these aspects of the relationship between teacher and student.

In the past, a good many radio and television programs which were designed to convey instructions and information have been largely instrumental in character. Nevertheless, mass communication is not necessarily lacking in all expressive elements; numerous audience studies have shown strong feelings of affection and admiration for such radio figures as Kate Smith or Franklin Roosevelt -- feelings which clearly enhanced the power of these figures to teach, persuade, and induce commitment to various values. This suggests that certain types of figures, used as television teachers, might well be both admired and emulated.

Indeed, there is considerable indication that the conventional classroom situation may not foster expressive relationships between teacher and student. Waller says, for instance, that a teacher cannot form "a real and vital contact with his students." (47-445) A Rutgers study of the informal communications patterns of adolescents shows that the teacher is rarely mentioned as a person to talk with -- and if at all, only on such topics as school work or political problems; whereas moral problems, social relationships in school and other topics of central concern to adolescents are discussed mainly with parents, siblings and friends in and outside of school. The various studies of democratic vs. authoritarian "climates" of teaching indicate that only under limited conditions do the students actually seem to learn more from the democratic or friendly teachers. (7) One important possibility here is that the type of expressive relationship which makes for effective teaching is not one of equalitarian friendship, but one of admiration of the teacher as a superior and distant figure.

Since the prestige and persuasiveness of the teacher may be closely related to his status in the larger social structure, this topic will be reserved for discussion in Section 5 below.

Some further problems

Thus far the effectiveness of the teaching process has been considered as an aspect of the immediate relationship between teacher and student. But this is clearly only part of the total picture. Any innovation must, therefore, be viewed in its place in the larger system.

Moreover, much further research seems clearly to be needed on the teacher-student relationship itself. While an impressive literature has reported on the study of the small group during the last decade (19), it is astonishing how little of this research has been carried out in the classroom. Thus much of the knowledge of communicative interaction, either instrumental or expressive, has not been investigated in its possible direct application to problems of innovation in education. Moreover, many problems familiar in the literature on communications research need further study for specific application to teaching. Such questions might be of interest here as: What expressive elements in the student-teacher relationship are most highly associated with effective teaching of values? Are distant mass media figures admired and emulated to the same extent as "live" teachers in the classroom? Are there variations in the "credibility" of educational messages as these may be communicated via new media, and how are these related to the learning process? Will differences in the interactive relationship between teachers and students produce "boomerang" and "sleeper" effects?

3. The Student and His Two Primary Systems: Peers and Parents

Types of innovations

Many of the new media innovations in the educational system will bear, directly or indirectly, intentionally or unintentionally, upon the role of the student himself. Some dimensions of possible change which would be significant for the student's role are:

--the audience for a radio or TV program might be large (as in an auditorium) or small (as in a classroom), or, at the extreme, a learning machine might "teach" a single student at a time;

--TV courses beamed into the home might reach the student as a member of a family group, rather than of a classroom group;

--"mass" teaching devices may result in the development of small discussion groups, either planned or spontaneous, which might be led by a teacher or a student, or which might arise outside of the school, in the home, or in the peer group.

Group relationships of the student

The basic sociological principle, widely supported through a variety of studies, which underlies any full understanding of such innovations may be stated as follows:

> The perceptions, motivations, attitudes, and behavior of an individual in the role of student tend to be guided by his relationship to family, friends, and other significant groups to which he belongs.

Throughout the process of socialization, such groups operate to shape the individual's values. Various members of these groups serve as role models to which the individual aspires. Moreover, the individual is in daily interaction with members of such groups. Sometimes he talks with them directly about his experiences in school, what he is learning, his homework, his teacher; and on all such specifics he obtains reactions -- approval or disapproval -- from these others. More generally, and perhaps more importantly, his interactions with these groups serve to develop broad frameworks within which he and they evaluate his teachers, his schooling, his ultimate educational and occupational goals.

Peer groups

Especially influential for many students are their groups of friends, both inside the classroom and the school, and outside the school entirely. The impact of such peer groups on the student role must, of course, be understood in terms of the particular values of each particular peer group. Some groups support the goals and norms of the school, others are indifferent but may place competing demands upon their members, and others openly rebel against the school. A Rutgers study of 2500 high school students in 8 middle class communities indicates that the great majority of students are being influenced by their peers to perform well as students and to look forward to an adult role of success and achievement. (38) By contrast another Rutgers study in a heterogeneous community shows that certain peer groups are very definitely re-enforcing the student's tendency toward truancy, neglect of school work, and early school leaving.[5]

It is undoubtedly because of such conflicts in the directions of peer group influence that no clear-cut correlation has been established between school performance as measured by grades and sociometric status in general -- that is, without regard to the values of the particular groups contributing to the status. Wayne Gordon in The Social System of the High School, for example, notes a low correlation between grade achievement and general status, indicating that high school students are primarily motivated "to accept those roles which would establish a prestige position in the informal organization." (14-22) The Rutgers studies show a general tendency for those in extremely low status to attain low grades, while those in extremely high status have large proportions of students scoring high grades. The relationship is not a simple one, yet there are some clear indications in the data that it is affected by the values of the peer group in which the status is achieved.

While further research is obviously needed on the values and structuring of peer groups within the school class, the evidence seems sufficient to provide certain guideposts for educational innovation. A student's willingness to perform -- if not his actual grades -- is conditioned by a) his relation to friends and b) the attitudes of these friends towards the goals of the school. If a proposed innovation were to make use of small discussion groups within the classroom, such groups might be based upon the already existent sociometric networks and friendship clusters. Each such cluster typically has an informal leader, who might be used as a teacher surrogate or a bridge from peer group to teacher. One probable consequence of this would be to perpetuate the alignment of certain groups on the side of conformity, while perhaps failing to motivate the deviant groups and bring them into line with the new program. An alternative would be to manipulate the structure for discussion purposes, so as to merge the rebellious and indifferent individuals with those who are already imbued with academic ambition.

The possibility of establishing new groups for formal teaching purposes which might in turn become entrenched as informal friendship groups seems feasible in the light of considerable experimental evidence. Festinger, Schachter and Back, for instance, demonstrated that those families who were geographically close to one another in a housing project developed close friendships among one another. (11) In similar fashion, the friendship groups of enlisted men in a barracks seem to be determined in large part by physical proximity. The implication seems to be that if interaction is facilitated, this tends to result in friendships.[6]

Parents

The individual student is a member, of course, not only of friendship groups, but also of a family. Like the school itself, the family is a major agent in the socialization of the individual. In terms of our two-fold objective of the educational process, there may perhaps be a rough and unspoken division of labor between family and school. The family, that is, may lay major emphasis on instilling in the child a pattern of broad social values, and inducing him to make certain commitments to his present role as a student and his future role as an adult. A great deal is known about this process as it applies to the socialization of the pre-school child. While less specific research has been done on the family's influence on the student as such, the general principle undoubtedly still holds that any individual guides his actions and shapes his attitudes so as to meet the expectations of significant others, such as his parents. To be sure, parental influence sometimes takes a negative effect, as adolescents go through phases of rejection of adult authority. Yet the Rutgers studies show, for example, that (at least in these middle class communities) high proportions of high school students aspire to meet parental expectations on such important values as being a "good student" and a "success as an adult" and "being popular" and "friendly." Thus the family emerges as an important potential ally of the educational system. On the other hand, whether particular families in fact perform this function depends again, of course, on whether or not their values are aligned with those of the school.

Within the family group it is important also to note the different roles of the mother and the father. Hyman suggests that American mothers may be more important in the indoctrination of their children than fathers (24-430), Parsons comments on the increasing responsibility for family management and influence on children (33-27), and the Rutgers studies show that the boys, as well as the girls, are disposed to communicate informally on a much wider variety of topics with their mothers than with their fathers. Thus the mother seems to be the direct and immediate focus of family influence, although there is nothing here to suggest that the more distant figure of the father may not still remain the more forceful role model. (30-130ff.)

If some such division of labor exists between family and school, the school is without question the primary agency for carrying out the second part of the educational objective: transmitting knowledge, developing capacities for carrying out of specific role assignments, and inculcating particular skills. In some such sense as this, it seems often to be assumed that the school and the family are simply two quite different orders of "social reality," that they strive toward different goals, that they operate quite differently in their daily routines, and that they simply aren't very closely related. Waller, whose classic in the field of educational sociology is generally felt to have at least pointed to most of the important problems, sets out this point of view: "Parents and teachers want to do different things with the child...[they] are involved in different alignments of group life affecting the child." (46-68) Brookover speaks of "the decreasing importance of the parents in the process of child training. ..." (8-246) and Williams, via his analytical survey of American society, makes it a major point when he writes:

> "It is one of the distinguishing marks of modern secularized societies that education has been so removed from kinship... groupings. Although...families do not always turn over their children to the school completely...the degree of separation of formal education from family...is extraordinarily extensive and sharp." (48-266)

The view that *formal* education in this sense is exclusively the function of the school is often challenged, however. For example, Foote and Cottrell in their recent survey of research on the family observed that,

> "An increasing number of studies show that children's [academic] performance is intimately related to their family situation. It is thus clear that parents cannot throw total responsibility for the performance of their children upon the schools. In order to share that responsibility most effectively, the parents' family situation may have to be looked at in the light of... avenues of reciprocity. ..." (12-141)

The ability of parents to participate in the teaching process is increasing, of course, as the general educational level of the adult population rises. The performance of educational functions by parents may become more and more essential, as new educational media may not only require revised patterns of homework, but may even mean that some classes may be "attended" at home.[7]

Position in the community

The full impact of the family on the role of the student can be seen only when the families themselves are located within the community structure. A good many important studies deal with the place of the family in the socio-economic hierarchy of the community. Hollingshead, in *Elmtown's Youth*, for example, demonstrates a striking relationship between family status in the community and the academic performance of the child. Thus one-half of the students from the highest status families in his sample received "honor" grades, whereas only 8% of the students from low status families were comparably successful in school. (23-172) Hollingshead speculates about a number of possible causes for this, including possible differences in native intelligence, and a higher motivation to perform in school which tends to be derived from families of higher status. Hyman, summarizing a whole series of national studies, shows that there are pronounced class differences in parental desires for their children's education, so that 91% of the prosperous class, but only 68% of the poor class, want their children to go to college. (24-432) Interestingly enough also, in view of the close contact between mothers and children, Hyman shows data to the effect that women emphasize the value of education more than their male counterparts in every age and socio-economic category. (24-430)

Talcott Parsons, reporting on a yet unpublished Harvard study of social mobility patterns among 4,000 Boston high school boys, pushes this analysis one step farther. This study first replicates the usual finding that children of high status families tend to do well in high school and to go on to college, whereas children of low status families are less apt to do well and are less likely to go to college. It then proceeds to stress the importance of those boys who do not fit into either of these characteristic patterns. Thus it points out that (even with I.Q. held constant) substantial numbers of high status boys do not perform well in high school, whereas substantial numbers of low status boys perform very well indeed. Thus family status (and I.Q.) alone are not sufficient in themselves to account for the level of school performance, and the Harvard sociologists attempt to investigate the matter further. First, they show that those who go successfully through the college course in high school are, broadly speaking, those whose record is good back in elementary school -- that some individuals from all types of families are consistently high achievers. And second, as Parsons puts it, they trace the distinction between achievers and non-achievers right back to the family as the underlying foundation of support which may or may not provide the emotional security which makes achievement possible. The tentative conclusion is summed up as follows:

> "...it may be said that the most important single predispositional factor with which the child enters the school is his level of independence. By this is meant his level of self-sufficiency relative to guidance by adults, his capacity to take responsibility and to make his own decisions in coping with new and varying situations. This, like his sex role, he has as a function of his experience in the family." (33-5)

"Local" and "cosmopolitan" families

Still further light might perhaps be shed on the influence of families upon their children-in-school, if these families were considered with regard to their location in the larger social structure -- quite apart from their status in the immediate community. Robert Merton has developed a typology of "local" families, whose primary social and occupational ties are close to home, who read local newspapers, are active in community affairs, and the like; and other "cosmopolitan" families, whose friends or occupations often lead them outside the community, and who concern themselves with national or international affairs. Such a typology might be useful in explaining why, even among high status families, children vary in their motivation to achieve. Cosmopolitan families may offer their children wider horizons, and perhaps a greater challenge. At the same time, such families may often confuse and discourage the child, presenting him vague or impossible goals, in contrast to the local families which have unified and moderate expectations both of the child and of the school. Such possibilities may take on greater meaning as new educational media may strengthen the cosmopolitan ties of students and perhaps also of parents (as well as teachers, as discussed in Section 4).

Peer-parent conflict

Thus peer group and family group are both definitely linked with the school in the total process of socialization, although the full patterning of such linkages is by no means clear. The total structure of peer groups and of families is highly differentiated, with some groups supporting school values and others not, with some groups more effective than others in instilling independence and initiative, and so on. As education advances, and new media are used, the delicate balances within such a structure may be expected to shift.

Of particular interest here is the fact that, for some children, family and peer group support each other, while other children must face sharp conflicts between expectations of parents and of peers. For middle class children, this conflict may be less severe than is popularly believed. The Rutgers studies show, for instance, a considerable tendency for parent and peer expectations to coincide, and a further tendency for adolescents to regard the peer group emphasis on "fun" as evanescent -- of little importance when looking ahead to the adult world. (38) If middle class children suffer from little conflict, this is probably much less true of lower class children. And there is considerable evidence to show that "cross-pressured" individuals work under handicaps (see Section 4).

Some further problems

While the evidence seems clear that the student's definitions of himself and his school, as well as his motivation to perform, are channeled through his family and his friends, much more exact knowledge on the nature of such channeling will be required. Answers seem needed to such questions as:

> How will his performance vary if he takes part in discussion groups composed of present friends? or in newly constructed discussion groups? or if he works apart from friends with a learning machine? or if the "lesson" reaches him at home as a member of his family?
>
> How will his performance vary depending on the basic attitudes of his friends toward school? of his family?
>
> What roles are actively played (intentionally or not) by different types of families (upper vs. lower class, cosmopolitans vs. locals) in:
>
> --forming basic values;
> --setting day-to-day patterns of reaction to school, evaluating teacher and homework, etc.;
> --transmitting specific knowledge and skills?
>
> How will the new media affect existing relationships between students and their friends and families?

4. The Teacher's Network of Relationships

Types of innovations

Some dimensions of possible educational change which require an understanding of the role of the teacher include:

1) The degree to which the teaching body (within a school or community) is structured, ranging from the present situation to a highly stratified hierarchy of teachers, as for example:

   --"super-teachers" at the top, either local or more centrally located, who teach over radio or television;
   --assistants and aides at the bottom, who merely supplement the super-teachers by leading discussions and performing the least professional of the classroom tasks;
   --perhaps in the middle the great majority of the present teachers, who continue to perform the more conventional roles.

2) The "social distance" between statuses, which might be small and vaguely defined or sharply demarcated (as between doctors, residents, interns, nurses, attendants, in a hospital).

3) The amount of upward mobility within the system, ranging from a rigid status structure to one in which teachers can see clear opportunities of advancement.

4) Variations in teacher recruitment policy, which might reach into lower socio-economic classes, and to the less capable or less highly trained for at least certain types of teacher assignments.

5) The degree of centralization of the teaching structure, involving possible extensions of the usual controversies over unified vs. non-unified districts, consolidated vs. non-consolidated schools, extent of state and federal control, and the like.

6) The degree to which teachers are expected to acquire new technical skills (use of learning machines, intercoms, projectors, etc.)

Group relationships, informal and formal

There are a number of basic sociological principles which seem applicable to an understanding of the probable impact of such innovations upon the teacher's role.

Paramount among these is the sociological axiom that, like the student:

> The teacher belongs to significant groups, both informal
> and formal, which tend to guide her behavior and influence
> her attitudes in her role as a teacher.

Thus any change in the teacher's role can only be fully understood against the background of these relationships.

Like the student, the teacher too has a network of informal group relationships which affect her perceptions, attitudes, motivation and behavior in her role as teacher.[8]

Within the boundaries of the school itself, she undoubtedly makes special friends of certain other teachers and staff members -- perhaps also developing jealousies or antagonistic feelings toward certain others.

Outside the school she also has groups of friends, and perhaps a family with which she lives. She may also have close relationships in various civic and religious groupings, and so on. What she does as a teacher will be in part conditioned by the expectations of these several significant groups. Thus her readiness to accept innovations in her role will in part depend upon the approval of such groups. She will presumably play a more cooperative part in a new teaching experiment if her friends admire the experiment, than if they regard it as a reduction in her status as a conventional teacher.

Moreover, as in the case of the student, the teacher's role is further potentially "conditioned" by the relative positions of her primary groups within the larger community. The fact that teachers typically now come from middle class family backgrounds, for example, may lead many of them to teach with a middle class bias, and this undoubtedly contributes to the degree of public esteem which they can command as teachers. Teachers from local families are reputed to be more readily accepted than those from outside the community. If innovation should lead to new emphases in the recruitment of teachers from different parts of the community structure, or if changes in the sex ratio of teachers are called for, i.e. more male teachers at the elementary and secondary school levels, these might lead also to changing public definitions of the status of teacher and hence to the inducements which motivate the teacher to perform.

Apart from such informal relationships, the teacher's role is inextricably bound up in the formal educational system. Within the school itself, the teacher has specified relationships, not only to pupils, but also to other teachers, principal and administrative staff. Within the community, rather rigid requirements for the teacher role are laid down by parents, alumni, parent-teacher clubs, the school board, the superintendent of schools, self-constituted advisory groups, and the like. And beyond the limits of the community, teachers are linked to the profession at large, through teacher associations, educational journals, and the schools of education in which they were trained.

Some implications of innovation

Thus in the light of basic sociological principles, it seems clear that any innovations which touch upon the role of the teacher will:

a) potentially affect other aspects of this network of relationships, which may in turn

b) react upon the role of the teacher itself -- her self-definitions, her self-confidence, her motivation to perform as a teacher.

To illustrate this through one or two speculative examples, consider the possible threat to the teacher's self-confidence implied by the requisite knowledge of new media and child response to such media. That many teachers do not customarily keep abreast of the experts even in knowledge of child behavior is evidenced by two studies made some years ago. In 1928 the Commonwealth Fund commissioned a broad investigation of the teaching role, and in the course of this study a sample of some 400 teachers was asked to rate a list of common behavioral problems in terms of their seriousness. Similarly a panel of expert psychologists and mental hygienists was asked to rate the same list. There was practically no correlation between the two rank orders. While the teachers gave high ratings to such items as defiance, untruthfulness, and minor sex offenses, the experts were worried about lack of sociability, fearfulness, and cruelty. (47) Twelve years later the study was replicated and although the "gap" had been narrowed somewhat, there still existed a wide discrepancy between the teachers and the experts. (22) To the extent that new media and new teaching programs serve to emphasize such discrepancies, this might produce a chain reaction of feelings of inadequacy on the part of the teacher followed by reduced confidence in her among her friends and colleagues, with a resultant decrease in the teacher's former level of performance in her role. As the Westinghouse studies have shown in industry, as a possibly useful analogy, any move on the part of management is apt to change the existing social equilibrium among the workers -- an equilibrium to which the workers have become accustomed and within which their familiar statuses are defined.

Alternatively, the teacher who requires new knowledge to meet the demands of teaching innovations may decide to go back to school. Here again the consequences reach far beyond the effect of re-training on the performance of her own role. Back at the university or the teacher's college she renews her ties with teachers all over the state or the country. She strengthens her associations with the teaching profession at large. And again these fresh associations have repercussions on her role. Perhaps she feels strengthened by the support of this wider group; or possibly she is shaken by their higher expectations which she may not feel competent to meet. This may combine with wider associations developed with other teachers as a consequence of an increasing tendency toward centralization. Such wider associations develop a new "cosmopolitan" emphasis in her role which may mean either a greater challenge or a greater threat. (This is similar to the dilemma confronting some students as discussed in Section 3.)

Where the teacher's status may possibly be threatened by the introduction of change, a variety of sociological findings suggest that this danger may often be counteracted by involving the teachers themselves in making plans and decisions about the change. In particular, a series of studies in industrial sociology conducted by Bavelas, Coch and French, indicate that involvement of the worker in decisions about change tends to enhance morale and productive efficiency. (3) (10) The effect of such involvement may well be to "save face," to protect the teacher's status with reference to others in the formal system.

In any case, an understanding of the consequences of innovation for the teaching role must take into account not only the teacher, but also the significant groups through which the teacher's values and motivations are mediated.

Role conflict

Although in general the individual is found to attempt to perform his role so as to meet the expectations of the significant formal and informal groups to which he belongs, the expectations of these groups sometimes conflict with one another. He then meets such "cross-pressures" in various characteristic ways, as a good deal of sociological research has shown. For example, the voting studies show tendencies for citizens to delay the voting decision, not to vote at all, or to veer at the last moment to the view of the larger community. (27) (4) In some such fashion, teachers too may well be expected, when group expectations conflict, to follow the usual patterns of hesitation, procrastination, or withdrawal.

It may well happen that innovation may increase cross-pressures of this sort, since changes typically spread through different parts of a system at different rates of speed. In industry it has been found, for example, that the technical organization can change more rapidly than the social organization, the formal organization more rapidly than the informal, and ideas can change more rapidly than patterns of interaction and of values. (41) Such disparities in innovation might well aggravate, among other things, the conflicts which even now frequently exist between lay school boards and professional standards. That conflict and strain at the administrative echelons may have the consequence of frustrating the teacher and reducing her teaching effectiveness is further suggested by a possible analogy from another field -- that of medical sociology -- where strains in a hospital administration have been found to interfere with treatment.

Some further problems

While a good many sociological principles and insights seem to be available which apply to the role of the teacher, much specific research is still needed in order to define the consequences of various possible innovations for this role. The time seems propitious for a series of case studies of educational organizations in a wide variety of social settings in which new educational media are introduced in controlled ways. Within such experimental situations, much important information might be gained about the reciprocal relationships between teachers and the significant formal and informal groups to which they belong. More specifically, which innovative elements tend, for example, to threaten the teacher, to reduce her formal or informal status, hence to diminish her teaching effectiveness? Or which elements enhance her status, challenge her skills, and motivate her to superior performance?

5. The System as a Whole

Thus it appears that the student and the teacher are each imbedded in a network of groupings, and that these groupings are themselves intertwined and interdependent within the community. This brings us back to the teaching process itself, which can no longer be viewed, as in Section 2 above, as a simple, direct relationship between two individuals. Messages initiated by the teacher tend to proliferate through the student's networks; and the reactions and responses come, not only from the student, but also from his family and friends -- and go not only to the teacher herself, but also to the members of her various groups. As innovations bear upon the role of the teacher, these in turn affect her relationship to the student and his network; and similarly, changes in the role of student may react upon the teacher and her network.

Within such an over-all system, let us consider a few final illustrations of this more complex character of the teaching process.

Complementary backgrounds of teacher and student

Any innovation will impinge upon the delicate meshing which exists in any community between the teacher's and the student's respective networks. Various studies depict this meshing in terms of favorable responses by teachers to students of similar backgrounds to theirs, who share the same values, preferences, and beliefs. (9) Hollingshead suggests that, in "Elmtown," teachers, presumably of middle class backgrounds themselves, tend to play an academic role vis-à-vis students from upper class homes, and a disciplinary role toward those from lower class homes; the upper class families in turn assume that good grades and prominence in school affairs are their natural due, and often apply pressure if necessary to obtain them. (23) Such evidence suggests that the respective places held by teacher and student in the community prevent equality among the several relationships; particularistic criteria intrude upon what is expected to be an essentially universalistic relationship.

Any given type of educational innovation might be predicted to have its characteristic consequence within such a situation. Recruitment of more teachers from the "lower classes" might strengthen the ties between them and the now less-favored lower class students. Or, introduction of purely impersonal figures on radio or television might have the effect of providing purely equalitarian treatment for all the students.

Mutual understanding of roles

An interesting question concerns the extent to which teacher and student must each understand the other's role, in order to make an optimum adjustment to each other and to the new media. Waller early suggested that both teacher and student are shut off "from real communication with each other. Students as well as teachers have put up walls." (46-445) To be sure, the teacher often wants to be understood by the student. And students, at least at the level of higher education, expect the teacher to be enthusiastic and to have sufficient empathy for his students to be able to encourage them to think for themselves (37) Yet there is indication of considerable ignorance on both sides. Studies in elementary schools, for instance, show teachers unable to estimate accurately the sociometric patterns in their classrooms, overestimating the friendship choices given to children whom they personally like. (16)

It seems clear that some person within the educational system -- though not necessarily the classroom teacher herself -- would need to determine sociometric patterns if innovations were to utilize them for any kind of supplementary function. Moreover, it seems possible that students and their families and friends must be given some sympathetic understanding of the teacher's role, if this is to be redefined within a revised structure.

Relative statuses of teachers and students

Whether improved understanding of the teacher may in fact be as functional for the learning process as admiration for the teacher as a prestigeful and perhaps distant figure is a question for further research.[9] In any case, various innovations bid fair, as Section 4 suggested, to change in one direction or the other the relative status of the conventional teacher. One set of innovations might serve to reduce it, by relegating most teachers to a position inferior to that of the "super-teacher," or by adding to the teaching body new recruits of lesser capacity and training. Another set of innovations might raise the status of the average teacher, by building a strong professional hierarchy, with first-rate performers at the top, and definite channels for upward mobility.

Either of these changes would affect the relationships between teachers, on the one hand, and students and their parents, on the other. A lowered teacher status might well reduce the high valuation now placed upon her by most parents, for example, thus curtailing the respect of her students. On the contrary, an improved teacher status might very well add to her teaching effectiveness. Such differences in the possible consequences of innovation are patently concomitant with the nature of the innovation itself and the procedure by which it is introduced. They merely illustrate once again the complexity of the system which will be affected by any change.

6. Critical Research Needs

While this inquiry has shown that sociologists are in a position to make certain contributions to the solution of some of the problems raised by the new educational media, it has, at the same time, emphasized the need for much new knowledge. Three areas for research seem to be especially promising and these may be summarized as follows:

1. *Formal studies of communicative acts in the classroom which utilize the theoretical models and technical procedures which have been worked out in research on small groups.* In particular, these studies might profitably focus upon two types of independent variables (as related to academic performance criteria): 1) the amount of feedback from student to teacher, i.e. the degree of interactivity between teachers and students, and 2) the nature of the teacher-student relationship, i.e. the extent to which instrumental or expressive qualities are present and emphasized.

2. *Field studies which further specify our knowledge of the educational implications of the student's relationship to his peers, on the one hand, and his parents, on the other.* We need to know how different types of families link up with the school and to gain some understanding of the processes underlying this linkage. Such knowledge may well become crucial if, in fact, the "dispersed classroom" of the future is in any way to involve the family. Furthermore, we need much further information on the so-called parent-peer conflict. While we have a fair comprehension of the importance of peer groups in the young student's

scheme of things we have little precise knowledge of how peer relationships fit together, or conflict with parent relationships, nor of the impact on the educational process when, in fact, cross pressures are generated by basic differences in values.

3. Studies of the changing role of the teacher as this is actually or potentially affected by new educational media. A series of comparative case studies in which the new media have been differentially introduced would seem potentially to be productive of much useful knowledge. While a good deal of research has shown that these media are effective and feasible, surprisingly little attention has been given to their consequences for the teaching role, e.g. the extent to which they threaten and thus reduce teacher effectiveness, or the extent to which they enhance the role and thus contribute to superior teaching performance. Furthermore, some basic research on the status of the teacher seems to be called for during this period of experimentation and change. The paradox of a high social valuation of education and a low relative status for the teaching profession needs creative study, especially at a time when unprecedented opportunities for improvement appear to exist.

FOOTNOTES

[1] We are primarily concerned in this paper with education at the elementary and secondary school levels.

[2] We shall define this model briefly, and shall then attempt to show how it might be used in order to:

a) locate points at which proposed innovations may be introduced in order to trace the paths along which the effects of such innovations may proliferate;

b) fit together any scattered pieces of available experience and research which seem to bear upon these crucial parts of the model, as these may perhaps guide immediate plans for innovation, or lead to hypotheses for further testing;

c) isolate areas of ignorance within the model which seem to require exploration through research if the full process of innovation is to be understood.

[3] Gouldner, who differentiates between a "rational model" and a "natural-system model," has recently suggested how a more powerful model might synthesize the two. (15-400ff.)

[4] The major sociological contributions must be carried over from work in other fields -- not education. It is a matter of general agreement among contemporary sociologists that there is not yet a well-defined field of educational sociology. To be sure, there is considerable sociological research activity being carried out on problems having some direct relevance to education, and sociologists are in increasing demand for teaching posts in schools of education and teacher-training institutes, but there exists no systematic or codified body of knowledge which could legitimately be referred to as the sociology of education.

The most recent and perhaps the most sophisticated "text" reports, for example, that "research evidence at present is not sufficient for conclusions and generalizations." (9-vii) And two recent reviews come to similar conclusions. Brim observes that "little effort [has been] made to formulate these [educational] problems in the theoretical terms of sociology." (6-10) And Gross characterizes the field as being both "underdeveloped and unfashionable." (17-128)

[5] An unpublished study in process by Jackson Toby.

[6] This hypothesis is discussed in detail by George Homans in The Human Group, Harcourt Brace and Company, New York, 1950.

[7] The parallelism between home training and school training, especially at the elementary level, is illustrated by a recent suggestion that classes might be conceived as "quasi-family," with each class in charge of a pair of teachers, a man and a woman. (12-142)

[8] In using the feminine gender in referring to the teaching role, no normative or prescriptive significance is intended. We are merely following customary usage.

[9] Studies, as by Hovland et al., on sources of communication, seem inadequate for answering such questions in the educational field.

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TELEVISION IN THE LIFE OF THE CHILD -- IMPLICATIONS FOR THE SCHOOL

By Wilbur Schramm

Dr. Schramm, who is Director of the Institute for Communication Research at Stanford, points out that a typical child already devotes one sixth of his waking hours to television outside school, and discusses the implications of this fact for the child's educability and for the use of television as a teaching aid.

This paper is concerned with an activity which fills approximately one sixth of the waking hours of an American child three years of age or over. It is an activity which ten years ago was known to only a few children, but in the last decade has replaced many of their other activities and rearranged their lives on a grand scale. Furthermore, this activity represents an experience so potent and flexible that it not only serves as the chief source of externally controlled recreation for children, but also is coming to be entrusted with a part of the teaching function of the schools. I refer, of course, to television.

We shall limit this discussion to television as it exists outside the school. This is the larger part of the iceberg, although from the viewpoint of our educational planning it floats below the surface. Whereas 10 per cent, at most, of American children have had the experience of being taught by television, at least 95 per cent of our children of school age have had the experience of recreational television, and 90 per cent of them have that experience quite regularly.

What is the pertinence of non-school television to a symposium on teaching media? We suggest that it may be pertinent for three reasons:

(1) Any experience that commands so large a part of a child's time, absorbs, and involves him so deeply, and leads him to identify as much as it does, must play some part in shaping the kind of child who comes to school: his interests, the breadth of his world, his status figures, his vocabulary, his ability to learn from pictures and the spoken word, and his capacity for being interested or bored.

(2) Television is the medium we most often talk about when we speak of the "new media" of instruction. Therefore, it behooves us to be interested in the skills in the use of television a child brings to school with him, what attitudes toward the medium he has learned outside school, and what habits of relating himself to television he has formed.

(3) Finally, school and community television tend to overlap. Not only is community television often related to classroom discussion, but there is a considerable amount of intentionally instructional material on the air. Children's use of community educational stations is not a large proportion of their listening, but it is still an impressive

total number of hours. And in some cases schools plan overlap between community and classroom use; for example, the Denver public schools repeat televised school programs in elementary foreign languages at the dinner hour, so that the child may review his lesson and practice the language with his parents.

Therefore, it seems potentially promising on this occasion to look at a child's out-of-school experience with television, and to see what implications may be derived for the schools.

1. The State of Research

I think it is fair to say that writing about television and children has been distinguished more for its heat than for its light. Geoffrey Gorer has pointed out that each time in our century when mass communications have got a new medium, the older people have blamed the new medium for all the defects they see in the young. The movies, the radio, and television have each in turn been blamed for juvenile delinquency. And before the movies, children were supposed to be corrupted by dime novels.

I am not merely speaking facetiously, for I am perfectly willing to be convinced of the enormous potency of television. Furthermore, as a parent and a teacher I sympathize with the uneasy feelings that have been responsible for starting innumerable investigations of what television may be doing to children. Some of these activities have been extensive and thoughtful, like the Kefauver Committee hearings of 1956. Most of them have been limited to collecting opinions or viewing with alarm. Very few have come up with any solid research evidence, and if they have sponsored any research, it has usually been descriptive rather than dynamic.

Bit by bit over the last ten years, however, solid information on children's viewing has become available. The first questions to be answered were those that commercial researchers had learned to answer for the networks and advertising agencies: How many children have access to television? how many view it, and for how long, and what are the favorite programs? This kind of information has appeared as an incidental by-product of commercial studies such as the annual surveys of "Videotown" (New Brunswick, New Jersey) for Cunningham and Walsh, and the American Research Bureau's studies of program popularity. Some of the most useful studies of this kind have not been commercial in their origin and intent. There have been, for example, the Battin survey of children's viewing in Ann Arbor, in 1951, the Remmers surveys of high school opinions and media behavior, and -- the most extensive of them all -- the annual surveys of several thousand school children, teachers, and parents in the Chicago area, by Paul Witty. His questionnaires are apparently very simple, and his analysis minimal, but his results make an interesting time series beginning with 1950.

In general, these studies suggest that a child in elementary school views television two to three and a half hours each day. This time increases in the seventh or eighth grade, then decreases again throughout high school. There are apparently considerable variations among individuals, and perhaps by location. Viewing is more extensive when television is new in the home. So far as program tastes are concerned, these have shown considerable evolution but no very clear pattern of change. The favorite programs of elementary school children in the early 1950's appeared to be Hopalong Cassidy and Howdy Doody; in recent years the favorite has been Disneyland, with Zorro running second. When Howdy Doody was the favorite of the 7 year olds, I Love Lucy was the choice of the 13 year olds. Now the 13 year olds prefer Westerns and crime drama. There is a very interesting study remaining to be done on the patterns and significance of changes in these program tastes, but such a study will not be as meaningful as it should be until we understand better than we do now why children are going to these programs and what use they are making of them.

One other finding from these descriptive studies should be noted: a very large number of adults in this country profess to be concerned over the effect of television on children. George Gallup reported in 1954 that "70 per cent of adults" placed at least part of the blame for "the upsurge in juvenile delinquency" on television. Witty's reports have consistently shown that something around 35 per cent of parents and teachers associate television with children's "adjustment problems."

Primitive as some of these descriptive studies may be, they have enabled us, for a number of years now, to feel fairly confident of being able to give at least a rough description of children's television behavior.

A step forward in television research, however, was the kind of study which we can illustrate by the work of Eleanor Maccoby and of John and Matilda Riley.

In each case these researchers tried to understand some of the *dynamics* of the relationship between children and television: how children relate themselves to the experience of television; what they are seeking, and what they probably carry away with them. Mrs. Maccoby, applying the trained observation of a child psychologist to home behavior and home relationships, was able to show that children in the upper middle class who are frustrated in their home life spend a great amount of time viewing television, where they presumably find vicarious satisfaction through fantasy. Frustration seems to make less difference, however, in the television habits of upper-lower class children, in whose homes long watching of television is a common pattern even in the absence of frustration. Thus, home patterns and home relationships clearly have something to do with the use a child makes of television.

The Rileys extended this kind of study to peer group relationships. They were able to show that the liking for programs of action and violence was significantly greater in children who used peers as a reference group than in those who used parents as a reference group. Furthermore, children who are seeking peer group membership select programs with social utility for that purpose. There are interesting differences in program selection between isolates and group members, and these differences seem to be not only in *what* is chosen, but also *why*. In other words, television use is intimately related to a child's social relationships inside and outside the home, and the medium is employed in different situations as a tool for changing these relations and as a substitute for more satisfactory relations.

It is interesting to notice that Mrs. Maccoby is one of the few researchers with deep experience in television who have consistently warned against possibly dangerous effects of television on children. She has challenged the idea that a child necessarily reduces his aggressive impulses by identifying himself with violent actors and actions on the television screen. The opposite may be the result: in many cases, the level of aggression may be increased. "The very children who are presumably using the program as an outlet for their aggressive feelings are the ones who carry away the aggressive content in their memories," she says. When and if the time comes for aggressive behavior in real life, these children are more likely to use the violent patterns they remember from television.

The net result of observations like these and studies like the ones we have just been describing is to draw our attention away from the broad and general considerations of descriptive research (e.g., the "average child" views three hours a day), and direct it toward the conditions under which children view, and especially toward the enormous differences in the needs they bring to television, and consequently in the uses they are prepared to make of it.

There have been a number of descriptive studies, but only a few, too few, of the Maccoby-Riley kind. Recently we have been presented a third kind of study which in a sense combines the first two, in a larger context. An example of this is Hilde Himmelweit's important book, *Television and the Child*, which not only gives us the best description yet available of the television behavior of British children, but also the most extensive effort yet in print to isolate some of the effects of television on the children who view it.

Collecting diaries and questionnaires from a large number of school children in London, Portsmouth, Sunderland, and Bristol, Mrs. Himmelweit was able to come up with 927 pairs of children, of age groups 10-11 and 13-14, matched for age, sex, social class, and intelligence. In Norwich she studied 185 pairs of similarly matched viewers and controls before and after television came to that city. With a great deal of painstaking work she was able to fill out most of a large factorial design, 40 cases to a cell. Thus she proceeded both with larger samples and more rigor than had been customary in the field.

This is not the place to try to summarize her 500-page book, but let us give at least some examples of her findings. The English children whom she studied viewed, on the average, a little less than American children of the same ages. The background factor most strongly correlated with amount of viewing turned out to be intelligence: the higher the child's intelligence, the less he viewed. Viewing in general took second place to outdoor play and social activities. Parental example was an important correlate of viewing; if the parents were selective and moderate viewers, so almost always were the children. Much of the children's viewing was devoted to adult programs, and three-fourths of the votes for favorite program, in her two age groups, went to presumably adult entertainment.

What does television do to a child's knowledge and skills? The net gain in knowledge she found to be zero or very slight, except in the case of the younger, duller viewers. Children can undoubtedly learn from television, she says; but viewing often replaces other learning experiences, such as reading books or magazines. On the whole, viewers hold their own scholastically with matched non-viewers, but the brighter children tend to fall a little behind their matched groups. Television, she thinks, may reduce children's progress in reading skill at first, but not in the long run. She found few cases in which students had been stimulated to creative activity by television. For example, very few of them had made anything after seeing it modeled on television. Television, she feels, stimulates *interest* rather than activity.

In fact, perhaps her outstanding finding is how little she was able to find that could be placed confidently under the heading of television effect. She could find no evidence, for example, that television made children more passive; nor that her viewers were any more aggressive or maladjusted than her controls. Defective eyesight was no more frequent among viewers than controls. Some very young and insecure children were frightened by Westerns, and many children were disturbed by danger to animals they liked (such as Lassie or Rin Tin Tin) or to characters with whom they could identify, especially when the danger or violence was realistic, rather than stylized as it is in Westerns. But children enjoy being a little frightened, she points out; and there is a narrow margin between pleasurable suspense and intolerable fear. One of the few sharp effects she was able to identify is that television on the average moved an English child's bedtime back about 20 minutes.

She found some evidence of an "addict" type, who is not exclusive to television, but rather is impelled by emotional insecurity and maladjustment to consume large quantities of any available mass medium. If television is available to such a child, he will view it excessively; if it is not available, he will go very often to the movies, listen to a great amount of radio, or read a large number of comics -- but not books. These children are apparently ones who have unsatisfactory relations with their peer groups, and often with their families. They select broadcasts of two escapist types -- adventure or mystery to give them the vicarious pleasure of an active, exciting life; and family serials to give them the vicarious happiness of identification with a warm and united family. Thus she comes out about where the Maccoby and Riley studies had pointed: "Within a given intelligence level, social class, and age group," she says, "the amount a child views gives an indication of the degree to which his life is satisfactory; heavy viewing is a symptom of unsatisfactory adjustment or of inadequate environmental facilities."

Mrs. Himmelweit's data were all from England. For the last two years a study of comparable scope has been under way at Stanford, using subjects from the United States and Canada. Subjects included a large sample from each grade in the San Francisco schools; the entire first, sixth, and tenth grades in five Rocky Mountain communities matched for different degrees of isolation and different lengths of time with television; the entire first, sixth, and tenth grades in two matched Canadian communities one of which has and the other does not have television; two hundred whole families interviewed as families; upwards of a thousand parents, and a considerable number of teachers and school administrators. The data are still being analyzed, but we shall be able to take an advance look at some of them in the following sections of this paper.

2. Some of the Natural History of Children's Television

Let us first fill in some descriptive notes.

Children's use of television begins very early. By the age of three (as Table 1 shows) one third of the children are already seeing television. (Indeed, I have been in more than one home, in the course of this study, where the baby's bassinet was pushed right up in front of the television set, and the young fellow's eyes were darting back and forth to follow the horses across the screen!) By the age of five, 80 per cent are viewing, and by the age of six, 90 per cent. This means that the average child brings to the first grade with him whatever adheres to his vocabulary, his values, and his picture of environment from several years of watching television.

TABLE 1. PERCENTAGE OF CHILDREN WHO HAD BEGUN BY GIVEN AGE TO USE GIVEN MEDIUM

Age	TV	Radio	Magazines	Comic Books	Movies	Books Read To Them	 They Read	Newspapers Read To Them	 They Read
2	14	11	3	1	1	38	0	0	0
3	37	20	11	6	8	58	0	0	0
4	65	27	20	17	21	72	2	4	0
5	82	40	33	35	39	74	9	9	0
6	91	47	41	50	60	75	40	12	9
7	94	53	53	61	70	75	73	12	44
8	95	62	59	68	76	75	86	12	59
9	96	65	62	70	77	75	89	12	71

(382 San Francisco children)

From the fifth or sixth year, television dominates leisure time. Table 2 describes the now familiar curve -- time of viewing rising from about two hours per day at the beginning of elementary school to three-plus in the seventh or eighth grade, then declining throughout high school.

TABLE 2. ESTIMATED HOURS OF TELEVISION VIEWING

Grade	Weekday M	 F	Sunday M	 F
2	2.2	2.1	2.5	2.8
4	2.2	2.2	2.1	2.6
6	2.5	2.6	2.3	2.6
8	3.2	3.2	3.6	3.2
10	2.8	2.5	3.5	3.4
12	2.5	2.1	2.8	3.1

(1740 San Francisco children)

This is notably greater than the time given any other mass medium. In fact, television fills from one half to three fourths of all media time. It is the one universal medium among children, as the following table shows:

TABLE 3. PERCENTAGE OF CHILDREN USING MEDIA AT ALL DURING SEMESTER

Percentage who used	Grade 1	2	3	4
TV	95	96	93	97
Radio	45	53	62	63
Movies	41	60	77	83
Comic books	47	55	76	60
Magazines	21	29	42	39
Books (outside school)	66	74	70	71
Newspapers	47	62	68	84

(848 San Francisco children)

But suppose we sharpen the focus still farther, and ask how many fifth and sixth graders used each of the media on any given day during a week when they kept a diary. These are the relevant figures:

TABLE 4. PERCENTAGE OF CHILDREN USING MEDIA ON ANY GIVEN DAY

Percentage who used	TV	Radio	Movies	Comics	Mags.	Books	Newspapers
Fifth grade	74	25	3	5	5	23	19
Sixth grade	74	32	3	8	6	17	22

(508 San Francisco children)

In other words, three quarters of all the fifth graders in our San Francisco sample were viewing television on any given day. In the diaries of fifth graders, television filled an average of about 145 minutes a day; as compared to reading which filled 40, radio 80, homework 88, and movies (a little less than one movie a week distributed over the days of the week) about 18 minutes. The free play time, as distinguished from media time, was only a little more than television time -- 182 minutes as against 145.

Now, to be sure, there are sizable individual and group variations in these figures. In the eighth grade, for example, 25 per cent of the children view television four hours or more on a school day, and 10 per cent view it a half hour or less. There is even a group of first graders who peer at the picture tube four hours or more a day. Our preliminary figures indicate that children in relatively isolated towns in the Rocky Mountain states spend considerably longer hours on television than do the children of busy San Francisco. And in San Francisco we found one of the few instances ever reported when children's use of television actually *falls off* during the week end. This was in diaries collected in the springtime, when the beaches, the mountains, and California sunshine compete with indoor television.

If one peels off the upper and lower 25 per cent, in terms of time spent on television, one finds remarkably different groups. If one then partitions these two groups at the seventh grade, one finds the older group of heavy viewers to be different both from their corresponding group of light viewers and from the other group of heavy viewers. We shall come back to these differences in a few minutes.

It hardly needs to be noted that television is very highly valued by children. Next to the book, it receives highest prestige rating among the media. Its prestige and its valuation, however, decline during the high school years. For example, when you devise a set of questions to find out which medium would be missed most if children had to do without it, you get results like this:

TABLE 5. MEDIUM THAT WOULD BE MISSED MOST

	Boys			Girls		
Medium	8th	10th	12th	8th	10th	12th grade
Books	6 %	5 %	5 %	7 %	6 %	13 %
Magazines	4	2	2	0	1	2
Newspapers	5	11	20	4	3	11
Comic Books	3	1	0	2	1	0
Television	71	58	33	61	45	38
Radio	4	17	32	22	39	33
Movies	3	5	4	3	3	4

(No response from about 3% of children. n = 650.)

Nevertheless, in the downward trend of these figures one must not lose sight of what they show as to television's real importance to these children. When we were interviewing entire families we tried to find out *who* in the family would miss each of the media if the family had to do without them for a *long* period. More than twice as many families as for any other medium said that *the whole family* would miss television. In the majority of cases, one person only (the mother) said she would really be the only one to miss radio, and one person only (the father) would seriously miss the newspaper. A startling 43 per cent of families said that *no one* in the family would miss theater movies. But parents and children alike would *sorely* miss television. We saw a dramatic illustration of that when we studied a Canadian community which does not have television. One TV set, and one set only, in the community was connected. The family who owned it had brought the set when they moved from another town that had television. On about three nights a year, some errant signals find their way to that aerial and deposit a snowy picture on the picture tube. But every night the family turn on that receiver, hoping that this is the night!

We have found nothing startlingly new about children's program tastes. As the child passes through the school years, childish programs are gradually replaced with adventure, crime, family serials, and popular dance. Disneyland and Zorro dominate the first six school years; 77 Sunset Strip, Maverick, American Bandstand, and Peter Gunn, the second six years. Boys hold on to childish programs longer than girls, but boys' and girls' tastes draw closer throughout the high school years. The reader may find it interesting to look at the list of the television programs said by San Francisco children of different ages to be their favorites: (See next page.)

We are unable to find any evidence that children make much use of educational television. For those persons who had hoped that this medium might attract children from less "educational" programs, our figures are bound to be disappointing. Two non-commercial community stations came within our several samples, and their attraction to child viewers was almost identical -- and slight. About 20 per cent of children in the first four grades seem to view these stations as often as once a week, and only about two per cent view them daily. Over 50 per cent do not watch the educational stations at all. In eighth through twelfth we get these results:

TABLE 6. VIEWING OF A COMMUNITY EDUCATIONAL STATION

	Boys			Girls		
Frequency	8th	10th	12th	8th	10th	12th
Not at all	62%	73%	59%	65%	73%	73%
Less than once a week	17	14	21	17	13	15
About once a week	9	6	13	6	3	3
Several times a week	9	5	4	9	3	3
Practically every day	2	1	1	1	3	4
n	114	85	123	105	116	109

(No response from about 2% of children.)

Furthermore, as these children move through the teen years, they tend to think less and less of educational television. Its prestige rating falls, and it tends often to be at variance with peer group norms. "Who looks at educational television?" more than one child among our interviewees told us. "I'll tell you who does: the squares!"

1st	2nd	3rd	4th	5th	6th
Disneyland	Disneyland	Disneyland	Disneyland	Disneyland	Zorro
"Cartoons"	Zorro	Zorro	Zorro	Zorro	Disneyland
Popeye	Popeye	"Cartoons"	"Cartoons"	Maverick	Amer.Bandstand
Zorro	"Cartoons"	Popeye	Popeye	Beaver	Father Knows Best
Mickey Mouse Club	Lassie	Mickey Mouse	Cheyenne	Danny Thomas	Maverick
Lassie	Mickey Mouse	Lassie	Lassie	Cheyenne	Topper
Capt. Fortune	Rin Tin Tin	Beaver	Rin Tin Tin	Father Knows Best	Cheyenne
"Westerns"	Cheyenne	Circus Boy	Mickey Mouse	Real McCoys	Beaver
Rin Tin Tin	Beaver	Amos and Andy	Real McCoys	Fury	Real McCoys
Leave It to Beaver	"Westerns"	Cheyenne	Danny Thomas	Sea Hunt	"Science Fiction"

8th		10th		12th	
Boys	Girls	Boys	Girls	Boys	Girls
Maverick	Amer.Band.	77 Sunset Strip	77 Sunset Strip	Peter Gunn	Peter Gunn
77 Sunset Strip	77 Sunset Strip	Maverick	Amer. Band.	Maverick	77 Sunset Strip
Sea Hunt	Maverick	Peter Gunn	Father Knows Best	77 Sunset Strip	Maverick
Rifleman	Father Knows Best	Amer. Band.	Maverick	Rifleman	Amer. Band.
Disneyland	Danny Thomas	Sea Hunt	Danny Thomas	Amer. Band.	Alfred Hitchcock
Peter Gunn	Peter Gunn	Rifleman	Peter Gunn	Gunsmoke	Father Knows Best
Amer. Band.	Ozzie and Harriet	Red Skelton	Wanted Dead or Alive	Bob Cummings	Steve Allen
Gunsmoke	Donna Reed	Father Knows Best	Donna Reed	Naked City	Real McCoys
Father Knows Best	Perry Mason	Beaver	Beaver	Father Knows Best	Danny Thomas
Steve Allen	Real McCoys	Steve Allen	Gunsmoke	Science Fiction Theater	Loretta Young
Science Fiction		Gunsmoke			

3. Notes toward Theory

What seems to be going on behind all this forest of data?

It may be foolhardy to try to answer a question like this when one is half through the analysis of his data. But at the cost of possibly having to revise judgments six months from now, I am going to set down a few notes on some of the molar patterns which at present seem to us to organize our molecular data. And first:

Parent-peer group relationship. In the first 10 to 12 years of a child's life, there is a very strong tendency for him to pattern his mass media behavior after that of older members of his family. One way to illustrate that is with tabulations on the viewing of a community educational television station.

TABLE 7. VIEWING OF COMMUNITY EDUCATIONAL TELEVISION

	Father views ETV		
	1 hour or more per week	Less than 1 hour	Not at all
Child views ETV			
1 hour or more	46 %	16 %	15%
Less than 1 hour	38	73	4
Not at all	16	10	81

	Mother views ETV		
	1 hour or more per week	Less than 1 hour	Not at all
Child views ETV			
1 hour or more	48 %	11 %	14 %
Less than 1 hour	26	74	0
Not at all	26	15	86

	Older child views ETV		
	1 hour or more per week	Less than 1 hour	Not at all
Younger child views ETV 1 hour or more	74 %	5 %	4 %
Less than 1 hour	13	87	4
Not at all	13	4	92

(185 mothers, 182 fathers, 442 children)

These tables suggest that the parents may hold stronger negative than positive power over some of the child's media behavior. If mother or father does not watch educational television, then the chances are better than 4 to 1 that the child will not watch it either; but if one of the parents watches educational television more than an hour a week, there is a little less than 50 per cent chance that the child will copy that behavior. (There is, by the way, very high correlation between mother and father in their watching of ETV.) The same parallelism between parents' and children's media tastes can be demonstrated in book reading, choice of newspaper content, and numerous other respects.

But as the child moves into his teens, this relationship to family patterns is no longer so easy to demonstrate. In these years the influence of the peer group and of new role concepts becomes much more important. We have now become accustomed, in reading the chronological curves of media behavior, to expect a certain amount of chaos in the seventh through tenth grades. This is apparently the point at which the conflict, if any, between parental and peer group influence on media use reaches its height. This is the period when the child is deciding which reference groups are important to him, when he is asking, "Who am I?" and building a pattern of adult behavior and values on the foundation of his behavior as a child.

Television as a replacement. When we compare the media behavior of high viewers with low viewers, viewers in a television community with their counterparts in a non-television community, or viewers before and after television arrives, we can see that television replaces certain activities in a child's life. If we follow Merton's theory of the equivalence of functions we can assume that television will be filling the same needs as the activities it replaces, and probably more efficiently. Therefore, what does it replace? The pattern varies somewhat with children, but in general television captures some of the time previously given to

play,
theater movies,
reading of fiction,
recreational radio,
sleep.

All these activities represent pleasure-seeking, escape, fantasy-making, or relaxation. It is reasonable to assume that these are the needs television is meeting, more efficiently and with less effort.

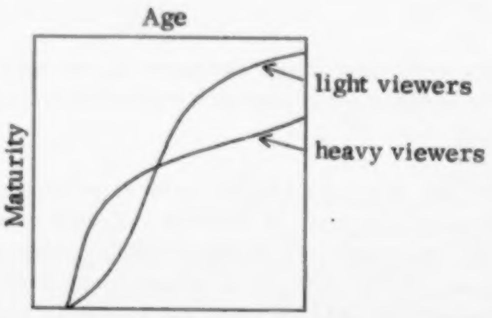
Most children, then, apparently go to television seeking chiefly what it can give them by way of fantasy, escape, recreation. If they go to seek instruction, or to engage in the hard work of learning from an educational program, there must be some special reason for doing so. In the teen years, when school work takes more time and effort and TV hours are necessarily reduced, the child tends first to give up the non-fantasy producing, non-escapist, non-relaxing part of television.

Both interviews and behavior suggest that the child typically develops a set toward television as a source of fantasy, escape, excitement, as opposed to information, instruction, and effort. This is one of the reasons why they tend to say that "only the squares" look at educational television.

Television and maturation. Television opens a very large showcase of adult experience to children. It used to be standard practice to ration this sort of experience, doling it out gradually at appropriate ages. Television has made this gradual input of adult experience very hard to accomplish. Seeking ever more need-satisfactions, accustoming himself to thrill play, the child samples more and more adult fare. Many third graders are regular watchers of crime and horror series, and many a second grader commands a sexy vocabulary even though he does not understand all its implications. In other words, the child attains a kind of "immature maturity", aged in experience before his time to use it.

Let us now return to what we said earlier about a difference between heavy viewers before and after the seventh grade. This division point, of course, is different for different children. But on the average we find that heavy viewers before the seventh grade are about as likely as light viewers to include the high I.Q. children. In other words, it looks as though television is more of an intellectual challenge before the seventh grade than afterward. After some point in the maturing process, the brighter children are more likely to seek greater challenges -- for example, from books or other printed media. For in the teen years, heavy viewing typically correlates with lower, rather than higher I.Q. The question suggests itself whether a heavy diet of television helps a child's development up to about the seventh grade, and from thereon hinders it.

This is an observation which recalls the often-made charge that television, on the average, is pitched about at the eighth grade level. Be this as it may, it seems that the rapid maturing which television brings about in a child is effective only so far. Heavy viewing brings additional maturing experiences to a young child, but after the child reaches a certain age heavy viewing may hold him back from experiences which might mature him more rapidly. If these assumptions are true, then we can hypothesize curves of intellectual maturity like this:



This is a very large hypothesis, and one that requires more proof than we can assemble at the moment. But it fits all the facts we now have in hand. For example, we studied a group of very high I.Q. children in the fourth and fifth grades. They were voracious television viewers; in fact, seemed to have insatiable appetites for all kinds of learning experiences, in school and out. The ones among them who thought school was dull were the ones who were not challenged by school. But when we looked at high-I.Q. children in eighth, tenth, and twelfth grades, we found a quite different situation. At these ages many of the brighter children had ceased to be heavy viewers and had turned toward other more challenging experiences, largely with print, experimentation, or creative arts. Their valuation of television had greatly fallen. And even among the average students, the prestige and valuation of television decreases as the student moves through the increasingly challenging intellectual experiences and personal relationships of high school.

We asked all students whether television was ever helpful in school. In the first six grades, there is no significant difference between bright and less bright children, or between heavy and light viewers; the trend is in the direction of a greater sense of helpfulness being felt by the heavy viewers. But in the later grades, the children who think television has been of most help to them are the brighter students who are light viewers. These light viewers apparently select programs which are of greater educational usefulness; the heavier viewers take a large dose of fantasy.

Class norms and television patterns. It is our tentative opinion that class norms and role prescriptions have a great deal to do with the way a child relates himself to television.

Achievement, upward mobility, activity, self-improvement, time perspective, deferred gratification, are all values which belong more often to the upper half than the lower half of our social structure. In the lower half we are more likely to find the values of present perspective, immediate gratification, relative lack of mobility, fantasy, passivity. If the words mean anything in this country, we can call the first group "middle class" values; the second group, "lower class."

Commercial television does not accord very well with middle class values. It stands for passivity rather than activity, immediate rather than deferred gratification, fantasy rather than realistic self-improvement, and so on. *Educational* television fits middle class values. Books do. But not most commercial television.

During the first ten years or so of life, the child is likely to accept the example of the family around him without a great deal of questioning or challenging. To an extent, therefore, his way of relating himself to television reflects the class norms and example of his family. But there comes a time, sooner with some children than others, but usually near the beginning of the teens, when the child challenges the norms under which he has been brought up. This is the time when he is searching for his own identity, deciding whether his parents or his peer group, or some combination, will serve for his reference group. This is a time of experiment, and sometimes of chaos.

A child who in this period strongly rejects one reference group is likely to turn to the other. But neither group is likely to be able to fill in all the need the other should be filling. Parents can't completely fill the need for peer group, or vice versa. So the child turns elsewhere, and very often he turns to television. Television, therefore, serves as a replacement, a retreat from unsatisfactory group relationships. In place of what life should be supplying, it offers its fantasy life. The excessive use of television which comes about when group relations fail is usually a temporary thing; the child repairs his human relations and returns to a moderate use of his escape valve. But recall that middle class values do not approve of much television experience. Then it must certainly happen that in some cases excessive use of television, when the child feels he shouldn't be doing it, leads to addiction. This is the pattern by which addicts are made -- excessive behavior of a kind which a person knows is not sanctioned.

We find that excessive television viewing at this period seems to go with introversion, high aggression, and, when we are in position to judge personal relationships, rejection of one or more of the important reference groups. As we might expect, the condition is more evident in children of middle class homes than children of lower class homes, if for no other reason because there is typically more television viewing in the latter.

This pattern is significant, not only because it helps to explain some of the behavior of children at this age, but also because it forecasts reaction to educational television. Educational television fits with middle class values. It is "achieving" active behavior, deferment of gratification in favor of the long-term reward of self-improvement. It is the same kind of behavior as much book reading, the reading of newspaper editorials and public affairs news, taking part in civic affairs, going to symphony. And this is exactly the kind of audience we find clustering around the community educational television stations.

Educational television is not necessarily intended for any such select audience; indeed, this may be the audience that needs it least. But the class normative pattern is bad news for educational television if it hopes greatly to enlarge its audience. For the child in a lower class home is likely to be surrounded both by family and peer group norms which tell him that educational television is "for the squares." (Indeed, when we find a lower class child who is a regular viewer of educational television, we find usually that he comes from a family that follows many of the middle class norms -- a family that is upward mobile, highly achieving, and so forth.) The middle class child has a good chance of being introduced to educational television by his family, but if he rejects his family in the early teens he is likely to reject educational television with it; and his peer groups are likely to be relatively non-intellectual and non-encouraging to educational television. Television, they feel, is for play, for relaxation, for retreat; why mix up work with it? As a result, when a child goes about restoring middle class normative behavior, he is more likely to take out his intellectual drives and interests in reading or in some activity like building radios.

A certain number of children, when they grow up, will find their way back to educational television. But we can assume that during their childhood, most of television's contribution to them will be fantasy.

The borders of fantasy. The question arises: when is this fantasy-seeking undesirable? when is it dangerous? We know at least enough to know that there is no simple answer to such questions. But let us set down a few suggestions.

When the fantasy world absorbs so much time that it keeps the child from fulfilling his obligations in the real world, then it is undesirable. When the border between the world of fantasy and the world of real life ceases to be clear, then it is potentially dangerous.

If the standards and behaviors of the fantasy world are carried over to the real world -- for example, if the child buries his social mores under a covering of fantasy (e.g., that he is a "good thief" like Robin Hood, or can use violence for "good" purposes as can Western heroes or Superman), or if when he is frustrated in the real world he tries out some of the violent behaviors he has seen in the fantasy world -- then we may have real trouble. A large proportion of the cases of juvenile crime which have been publicly associated with television have apparently been cases in which seriously disturbed children were unable to observe the borders between fantasy and real worlds, and have apparently gone to the fantasy world for standards and behaviors to use outside it.

Of the two ways of looking at this relationship -- what television does to children, and what children do with television -- there is no doubt in our minds which is the more important. It is what children do with television -- which depends in turn on the needs and the patterns of need-fulfillment with which children go to television. What happens to them in their families, their peer groups, their schools, and their intellectual inheritance largely determine what happens to them before the television screen.

4. Implications for Instruction

What are the implications for instruction?

If we are reasonably correct in these interpretations and generalizations, then television is presenting the schools with a child who is ready for a faster start but tends to slow down in the stretch.

Although we have not yet been able to test first grade vocabulary scores in television towns against those in pre-television towns, pending availability of some of the intelligence test data, we are regularly finding in the television towns vocabulary scores about 30 per cent higher than the norms for first grade children when our tests were standardized 20 years ago. There is also evidence that the child is entering school with a wider world of reference points and status figures than before television; with a sometimes astonishing though often superficial knowledge of certain parts of science and politics; and with somewhat different standards of aesthetics and entertainment. We have already noted that today's child is exposed very early to certain "adult" kinds of information.

This precocity is a challenge to the schools. But it is not an easy challenge. To deal with "immature maturity" is a very difficult task. The student becomes bored very easily; on the other hand, he talks about and recognizes more than he understands. It must take great skill to make sure that lesson materials do not seem too elementary and still do not neglect the basic understandings which the child may have skipped. It must take great skill to recognize the landmarks in the child's television world, and lead him from those to the other landmarks more properly a part of the school experience.

It is clear that today's child comes to school accustomed to enjoying, concentrating on, and learning from television or its film counterpart. This is a challenge to the teacher to use films and other pictorial materials to enrich the classroom. But even this is not something that can be done easily. The child comes to school accustomed to a very high level of showmanship. He is used to presentation that is swift and absorbing. He probably goes to television for thrill play in the same way as he rides a roller coaster or shoots firecrackers. This is pretty stiff competition for teaching films or instructional television. And yet if his instructional television or films, or even his face-to-face teaching, contrasts too greatly with the expertness and excitement he is used to, then, as every teacher knows, his capacity for being bored is phenomenal.

But it is clear that the conditions are there for a faster start if the schools can take advantage of them. Now let us look at the situation which seems to pertain in the later grades.

In many ways, what we have reported concerning television and its apparent correlates in the latter half of public school, is bad news. If these observations are correct and general, then it appears that the informational bonus from television is not very helpful beyond the sixth grade. For the great bulk of children over 11, television seems to pre-empt some time that might be used for more useful experiences. Only a small group of brighter students, it would seem, find the most intellectually helpful parts of television in their teen years. These students spend less time than average on the medium, but have learned to be highly selective about their programs. Indeed, they are typically above-average readers of print, and below-average viewers of television, so far as time goes. They are the chief users of educational television in the teen years, insofar as there is any considerable use of it by teenagers. It is interesting, but not encouraging, to find that the use of community educational television seems not to be a typical part of television behavior at all, but rather to correlate with high-print and low-television use.

These children who have learned to seek the more intellectually rewarding parts of television in addition to its opiates, are the exception. The majority of children seem to develop a set toward television as a place to go for fantasy or escape; and certainly for entertainment, not effort. If nothing can be done about that set, then not only may it be difficult to lead these children to the greater intellectual rewards to be found in television, but also to make them good users of educational television and film.

Therefore, it would seem that the schools may have to concern themselves with the sets and stereotypes and norms which -- in addition to television's own content - keep television from being a better learning experience for children after the early elementary grades.

How can we teach more selective program tastes? Television, no matter what we may sometimes think of it, is not devoid of intellectual stimulation. Many of the brighter students find that stimulation; how can we teach others to do so? How can we break down the stereotype that "only the squares look at educational television"? If we can't break it down, not only will education be losing a useful ally during years of need, but also the infection may spread to classroom television.

I suppose that one of the objectives of the schools might be to produce a larger proportion of graduates who fit into what we might call the "realist" group, as opposed to the "escapists." By this we do not mean that they should necessarily turn students away from television toward print, but rather encourage them to make a more realistic and informative use of all media -- to face up to life, rather than escaping from it. I recognize that it is easier to say this should be done, than to say how it should be done, or to do it.

But the division of experience, and the marking of the boundaries, between fantasy and realism, is coming to bulk larger and larger in our thoughts as we study the mass media. The school finds itself squarely in the middle of the problem, because it is -- along with the family and the mass media themselves -- one of three great institutions able to have some influence on the sets and stereotypes and norms which determine what kind of experience children have with television.

"What television does to children", so far as it does anything, is controllable to some extent through the content of television. And if schools and their related organizations have good reason to believe that some content is potentially harmful to children, then they have a responsibility to say so.

But the more important side of the relationship -- what children do with television -- is also controllable to some extent through family environment and example, and through the kinds of peer adjustment, goal aspirations, and media tastes we teach. The school is by no means helpless in this situation. It clearly has something to do with inculcating goal aspirations and media tastes. If a child doesn't know there is intellectually stimulating material on television, the school bears some responsibility. If the child has forgotten the excitement of using television for realism rather than fantasy, then that is partly the school's responsibility, also. If a child seeks fantasy to meet pressing needs which grow out of unsatisfactory peer group and family relationships, then we must ask whether our counselling has done all it could. Many a child has been helped to better social adjustment by school counselling, and many a disturbed and aggressive child has been identified and helped before he could make an undesirable use of violence learned from the mass media.

5. Suggestions for Research

The range of needed research on television is enormous. I shall restrict the field by suggesting topics which are neither concerned with television per se, nor with instructional television, but rather with the part television plays in the life of the child and especially in relation to learning and maturing.

1. Long term studies

Any significant "effects" of television are probably long term effects. One of the reasons why excellent studies like Himmelweit's have uncovered so little that might be called effect is because they have not observed effects over long periods. Long-term research of this kind is extremely difficult to design and carry out. The Stanford study is approximating it by studying a broad range of ages under the same environmental conditions. In addition to this, however, we need studies of children and television, programmed to last between 5 and 10 years and to observe a number of children carefully and repeatedly during that period. Only this way can we make safe generalizations about the way television enters into maturation, and relates to the formation of personality qualities and group relationships.

2. Dynamic studies

It would be desirable to have more studies of the Maccoby and Riley kind, endeavoring to understand some of the dynamic relationships among media behavior and family and peer group relationships, and developing role concepts. We need studies like this much worse than we need further descriptive studies.

3. Case studies

We need some close and careful case studies of unusual television-child relationships -- for example, of delinquent children who are thought to have derived some of their motivation or behavior patterns from television; of disturbed children, who are not always able to distinguish between the fantasy world of TV and the world around it; of children who have significantly risen above or fallen below the media behavior of their parents. Studies like these will answer some of our most pressing and bothersome questions concerning how television enters into life patterns.

4. Studies in taste formation

Can a teacher or a parent do anything about the patterns of taste which a child forms? Can a child really be taught to like more informative, less escapist programs? What can be done to lead more children into the realist, as opposed to the escapist group of media users? The only way we can be confident of the answers to such questions is to mount some research on taste formation, and some experiments in changing tastes.

5. Studies in television inside and outside school

We really know very little about how a child's use of television outside school relates to his ability to learn from instructional television in the classroom. In this paper certain reasonable-sounding suppositions have been made about how early experience with television will help a child to learn from the silver screen and the picture tube, and how a set toward television as a source of fantasy will hinder a child from using television as a learning tool. But these suppositions and others need to be checked further.

6. Studies of ability to comprehend television programs

We know really very little about how the social and intellectual maturity of a child relates to his ability to comprehend and enjoy a given kind of television program or lesson. Mrs. Himmelweit has pointed out that lack of understanding is not necessarily accompanied by lack of enjoyment; young children enjoy action even when they cannot understand the motives behind the action. It would be helpful to study, also, reactions of children to programs which they can understand intellectually, but for which they have as yet little emotional empathy. A few studies like this would help us to understand the kinds of experiences maturing children have with television, and what we can expect them to absorb, at different stages of development, from different kinds of material.

7. The nature of the TV world

We know only in a vague and general way, now, what images of television personalities a child derives, and what impressions he has of places and cultures he has seen on television but never face-to-face. Yet this is the kind of information he brings with him to school, and the map of the world which competes in his mind with the map of the world he learns in school. A study of these television-derived world views would tell us something of what we can use and what we have to compete with.

8. Studies of learning from television

A great many questions about the way a child learns from television are still quite hazy. For example, if he is interested in a program does he really learn more from it than if he is not interested? If information is given by a favorite television personality, is the child more likely to learn it than if it is given by a prestige figure whom he has never seen before, or by an unknown person? Is incidental learning or motivated learning more effective and lasting? As Mrs. Himmelweit suggests, we need to look at the whole problem of how a child's general knowledge builds up -- how much from a gradual accumulation of facts, how much by leaps and bounds; by piecemeal acquisition of details, or by perceiving grand relationships. If we could understand this process better than we do, we should be in a better position to make television useful to children.

9. Studies of how children's programs are developed

When we are in critical moods, it sometimes seems to us that children's programs on television may be thought up by Rin Tin Tin and written by Lassie. We know, however, that some of these programs have had very careful planning, and many of them are quite expensive. It would be interesting and helpful to know the histories of some of the better known children's programs, both admired ones and less admired ones. We should like to know, for example, what were the motivations for the selection of the subject matter and chief characters; what assumptions concerning childhood interests and needs lay behind the choices; what experts, if any, entered into the planning and preparation of the program; what considerations of sponsorship, what assumptions as to the kind of entertainment television can present, what experiences with codes, taboos, and censorship the program has had, what audience reactions it has had, -- and so on. After we know things like this, we shall be in better position to know what are the prospects of our help or any other help improving children's programs.

10. The use of outside television to help learning in the classroom

This is not the same problem as (5). Here we are referring to case histories and scientific evaluations of experiments like that of Denver with repeating classroom telecasts outside school hours in the hope of involving children's families in the process of learning and review; and of attempts to use commercial television programs as "outside reading," or as a basis for classroom discussions. Another operation worth studying is the attempt to motivate children with television to do something creative. Our general observation has been that television will arouse interest much more efficiently than it will motivate action. It will teach facts and skills much better than it will teach problem solving, critical thinking, or creativity. But there have been occasions when it has stimulated creativity, and these need to be studied and analyzed. Even as simple a study as a thoughtful analysis of one week of commercial television for its possible contributions to school at various levels, would be useful and perhaps eye-opening.

But of potentially "useful" and "perhaps eye-opening" studies in this field there is no scarcity! The scarcity is in researchers and financing.

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III

RESEARCH FOREGROUND

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APPROACHES TO PROMISING AREAS OF RESEARCH IN THE FIELD OF INSTRUCTIONAL TELEVISION

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Dr. Carpenter is Professor of Psychology and Director of Academic Research and Services at Penn State. Since 1947 he has headed an extensive program of film and television research. Here he discusses the state of research in instructional television, and suggests some tactics and strategy for advancing research in the area.

I. Introduction

The main purpose of this paper is to chart the broad topography of instructional television research. To do this, it is necessary to outline the general functional characteristics of instructional television, to consider a "systems approach" and its relevance to finding the roles of instructional television, to assess briefly research which has been emphasized, and to outline new areas of promise for research. The final section of this paper will outline suggestions for the improvement of research programs on the "new" media.

While a conference of this type can be expected to evaluate research achievements and outline areas of future promise, there are functions related to research which cannot be solved in any conference. These functions are: 1. Refined definitions of specific problems or hypotheses. 2. Detailed design of experiments, and 3. The assessment of requirements and resources needed to carry out specific research projects and programs. These functions must be the responsibility of individuals working over relatively long periods of time and within the resources and limitations of situations where the research is to be done. Therefore, this paper on the topography of research in the field of instructional television will be general and prospective. It is hoped that it will be provocative and will stimulate a resurgence of research in the areas of the "new" media, especially television, applied to the advancement of education.

II. A Conception of Functional Characteristics of Television as An Instructional Medium

Research is directed discovery. In order to have direction, research must have orienting conceptual systems including clear goals. Furthermore, the boundaries of any proposed research should be defined. Research in the modern communications media is still in need of rigorous concepts and definitions. These are especially important for the relatively new instrument of television applied in contemporary education.

What is television? Television is a multi-dimensional and general medium of communication. It is an instrument capable of encoding, transforming, transmitting or projecting, or re-transforming and then presenting the encoded patterns of meaningful information. These processes are performed so that the information input has correspondence with the information output. Furthermore, the psycho-physical correspondence between the content and the intentions of the communicator and the receptive and responsive behavior of the perceiver can be regulated.

Therefore, television can provide for most of the requirements of the exchange, interchange and distribution of information. It also imposes a set of special characteristics on information processing, instructional materials, and general communication. In brief, as with all media, television can form and mold in special ways the structure of the information transmitted through the systems. These effects have important implications both for teaching and learning.

Let us note some examples. Television is not as yet stereoscopic. The sizes of objects are varied. These are usually reduced but objects can also be magnified. Fields of view are limited and images are perceived on a bounded translucent screen. High fidelity color is as yet rare. Fields of information are presented rather than lines as in print and these fields must be scanned and abstracted by learners.

There are other important functional characteristics. A source of information can be almost infinitely multiplied as the number of receivers is increased. The single source informational input can be distributed and simultaneously presented over vast geographic areas. Furthermore, networks of connected origination points permit the collecting of information from many distant sources. Thus, the "space spanning" or collective and distributive possibilities of television can be used both to mobilize and extend learning resources. The compatible media of films and magnetic tape, print, graphics, pictures and sound recordings, can be used with television. These auxiliary media make it possible to collect, organize and present an almost limitless variety and quantity of information or stimulus materials and learning resources. Thus, "time-binding", time management and control potentials are provided by integrated systems of the media.

Television is a general medium in that most, if not all, other media of instruction can be used in conjunction with it, or can be channelled through its systems. Television is capable of handling with fidelity a range of semantic levels and complex patterns of communicative signs, cues, and symbols. Objects as well as complex situations can be encoded, transmitted and presented. These semantic levels may include complex abstractions such as principles, generalizations, inferences, and aesthetic qualities.

These considerations lead to two problems. There is the problem of developing a taxonomy of the media. In such a taxonomy the characteristics of the media would be made descriptively explicit. When this is done and accepted, there would be a clearer understanding than at present of what a medium is and how the various media are similar and different, compatible and incompatible. Furthermore, the possibilities would be reduced of confusing the media with the information or the instruction which is mediated by them or with the responses of learners. The error here is that of attributing characteristics to television as an instrument which are characteristics of the instruction or the responses of those who learn. Although a medium may modify the form of the "message", the medium is not the "message". However, the medium may have varied degrees of contingency to the effects on the behavior of people.

This brief characterization of television as a medium which is becoming widely available for teaching and learning at many levels of schools and colleges leads to the broad fundamental question of television's possible role in education; the answer to which should be sought through purposive research.

To what degree, or within what limits does television as an instrument have important capabilities for mediating significant educational influences? More specifically, what are the potentials of television for providing and regulating both general and specific conditions for learning? What are its potentials for mediating teaching functions and for instigating the learning activities of students? Can television be used for testing, for reinforcing, confirming, and evaluating intellectual achievements? To what extent can television be employed for increasing the effectiveness of learning and development of the individuals? What combinations of conditions, media opportunities and resources are required to maximize learning and intellectual development and what is the appropriate role of television in these combinations? To answer these questions would seem to require some revision in approaches both to educational operations and to research on the "new"media.

III. A Suggested Systems Approach to Teaching and Learning

Research on how, when and where to use television in education may benefit from an adaptation of the systems analysis approach to the problems. This approach, which has been developed and tested in military contexts and is being extensively used in industry, may prove to be helpful in integrating the "new"media, including television, into our schools and institutions of higher education.

The general requirements are known for employing this higher order "man-machine systems approach" to the solutions of complex operational problems like those of education and including the media sub-systems. They are the following:

1. Achievement or performance goals are defined. 2. These goals are then translated into sub-systems of general and specific functions. 3. The means of executing these functions are specified, and components of the systems are defined to include human capabilities, machines, materials and their interaction in the system. 4. Distinctions are made between those functions which can best be performed by persons with known competencies and those which can best be performed by instrumentation and materials with known characteristics. 5. Schedules and sequences of events are so planned that all components of the system, sub-systems and functions operate as required and in an orderly manner. The designed system, when tested and retested, may have its components changed or re-ordered to maximize the performance of the system as a whole in accomplishing projected goals or objectives.

A systems design for an educational enterprise would provide: A conceptual framework for planning, orderly consideration of functions and resources, including personnel and technical facilities such as television, the kinds and amount of resources needed, and a phased and ordered sequence of events leading to the accomplishment of specified and operationally defined achievements. A systems approach should provide a way of checking on the relation of performances of all components to factors of economy and should reveal any inadequacies of the several components, including the faults of timing and consequently of the entire system.

Let us now consider three limited or bounded sub-systems of an assumed total system with the purpose of illustrating those instructional operations which might be performed by communication instruments. Television and supplemental means of recording and storing stimulus materials are assumed to be available as well as a vast range of other teaching and learning resources, including some which need to be invented and constructed. These are classed as mediating instruments.

Three closely related sub-systems of a simplified communications model are the teaching functions, the mediating functions and the learning functions. These sub-systems correspond somewhat to (a) the informational inputs, (b) the information-handling functions of media, and (c) the activities of learners or audiences. The problem is to define relatively homogeneous functions and align them in these three categories, and then arrange them in an order of theoretical and practical significance relative to learning goals. The following table illustrates what is being suggested. (See next page.)

This table illustrates examples of three sets of functions and suggests the possibility of so defining the specific teaching-learning functions as to make it possible, through analytical research and programming, to define which functions may be acceptably and effectively served by different media, including television. Such functions as presenting and repeating organized stimulus materials can be completely mediated. Some functions can be mediated better than others; for example, presentations compared with evaluations. Some functions may not be mediated; for example, intensive discussion of issues between a teacher and a student. Different media may need to be used for different functions or conventional ways of using media may need to be radically changed.

Significant questions arise: Given a total educational system with defined achievement goals, and considering the mediating operations, what facilities or combination of facilities are needed? If presently developed instrumentations are inadequate, what facilities need to be invented? What improvements and modifications are needed in the functional characteristics of available facilities? Given the best possible teaching facilities including television, what are the ultimate performance limits? For what functions are people essential? What kinds of people are needed and how are they to be selected and trained?

The alignment of various teaching, mediating and learning functions, even in the limited example given, helps focus attention on some basic problems: 1. Ordering, sequencing, and programming of information for effective learning. 2. Determining the rates, difficulty and semantic levels of information appropriately gauged for the students who are to be taught. 3. The heuristics of instruction, learning, problem-solving and remembering. 4. Building into instructional programs inherent interest or inherent movitation for learning. 5. Means and methods of compensating for limitations of the mediating instrument systems and especially the control of social and cultural forces to support learning activities. 6. Artful and effective phasing of learning cycles consisting of acquisition, assimilation and transformation, and evaluation of academic or learning gains. 7. Correctly placing the responsibilities for learning on the students themselves and developing in students a conscience for learning.

Table 1

Examples of Functions in Three Related Sub-Systems of Instruction

Teaching Functions	Mediating Functions	Learning Functions
additional	additional	additional
Collecting, organizing and programming information	Mediating instruments	Scheduling and ordering learning activities
Presenting information in organized patterns	Mediating instruments	Perceiving and reacting to and with instruction, transforming and translating
Adjusting amount, levels of complexity and rates of information to known characteristics of learners	Mediating instruments	Attempting to understand, learn and remember kinds and levels of the materials presented
Arranging presentations to instigate effective learning activities of students and activate intrinsic motivation	Mediating instruments	Solving problems, completing sequences of thought and reasoning, formulating and applying principles, making inferences
Repeating the presentations of information to be learned with adequate internal redundancy and variations	Mediating instruments	Repeating, learning, condensing, reorganizing materials, completing sequences, making inferences and applications
Serving as an authority, example or model	Mediating instruments	Incorporating characteristics of model in personal behavior
Testing and evaluating achievements of students	Mediating instruments	Judging and evaluating levels of achievement in relation to expectancies and goals
additional	additional	additional

Many of these kinds of problems require meticulous research, staged under laboratory controls, and free from the pressures of immediate application. Others of the problems can be solved in operating situations by contextual research. It should be observed also that most of the problems identified by an analysis of teaching, mediating and learning sub-systems will be rooted in the very fundamentals of all education where "new" media research may reveal new essentials of learning and new research problems.

IV. Research Areas of Recent Emphasis

Instructional television research is limited roughly to the decade of the 1950s. Brief descriptions will be made of the questions and answers of this period of research on instructional television.

We will not review the research reports in detail. This kind of review was done by Kumata in 1956 (22), and briefly brought up to date in 1958. Systematic literature reviewing and abstracting projects are in progress at Penn State, Michigan State and perhaps elsewhere.

Reports have been made of the early research sponsored by the Navy's Special Devices Center and of the later work done by the Army's Human Resources Research Organization and the Signal Corps. (15, 18, 19 & 20). Recently the Fund for the Advancement of Education has published a brief general review of the many instructional research projects which have been sponsored by that Fund since about 1954 (35). Siepmann published his personal observations and interpretations in 1958 (33).

The majority of the published results of research on instructional television have been in bulletin form. This type of publication has been used both by the military services and the foundation-supported projects. There has been neglect of professional journal and even book publications. This apparently has resulted from the type of financial support available, and, in addition, from a kind of haste or urgency that almost amounts to an anxiety to publish quickly the results of television research. This sense of urgency may have resulted in a lack of maturity in some of the literature sources.

There have been several especially noteworthy working conferences which have published full reports:

1. The results of the Yale University-Eastman Kodak conferences of 1953-1954 have been well edited and reported by Miller (11) under the title of Graphic Communications and the Crisis in Education (1957). This report is of basic importance not only because it presents research findings on the mass media applied in education but also because of the many research problems suggested for investigation. Both tasks are done in a context of a systematic learning theory with the sound motion picture being used as a medium prototype. However, most of the facts, concepts and principles apply generally to problems of instruction by television as well as to other media and instructional materials channelled through them.

2. The American Council on Education co-sponsored with the Pennsylvania State University in 1957 a conference on College Teaching by Television and a book report was published under the same title (6). This conference attempted to assess both research and practical developments up to 1957, and, also, to formulate a perspective

of future developments. Like so many of the publications in this field, the principal considerations were of solutions to practical educational problems. Here, too, a sense of urgency pervaded this conference and is reflected in the report.

Other task-oriented conferences have been held. The Advisory Group on Education of the National Academy of Science sponsored the Easton Conference (1958) and Woods Hole Seminar on Fundamentals of Education (1959) (31, 36). Both conferences blocked out research areas considered to be important to education basically, and also focused some attention on use of the media as means for teaching and learning and accomplishing the enormous tasks of curricular education.

Last Spring (1959) the National Education Association's Division of Audio Visual Instruction conducted a conference focused on considerations of interactions relevant to learning, especially the reaction possibilities and limitations in instruction with television mediation. The conference emphasized a complex of problems which may be productive for research (16).

Let us now attempt to assess where we stand in instructional television research.

Primarily the questions that have been asked of investigators have been in the area of the practical operations and the management of education when television is used. The generic questions have been: Can teaching by television be done? How can it be done? What are the effects relative to a wide range of other comparable conventional arrangements? What are the practical problems, the economy and cost factors?

Another way of expressing the emphasis of the past decade of research on instructional television is to define the main problem as three sub-divisions of a central question: How are the large numbers of pupils and college students to be educated with: (a) predictable relative shortages of teachers, (b) rising costs of education for each student without commensurate increases in revenue to meet these increasing costs plus additional demands made by the increasing numbers of students, and (c) shortages of buildings and facilities for handling the nation's rapidly expanding educational enterprises. The research has been staged in the context of a defined national crisis.

The research on the use of television for military training was also staged in terms of an assumed national crisis when "millions of men would be mobilized and rapidly trained in a wide variety of job assignments to high levels of proficiency."

Emphasis has been put on questions of the possibilities of improving the quality of education by using television. Here there are two kinds of question: (a) Given an educational institution or system with adequate numbers of teachers, but with a wide range of quality, is it possible by having the best teacher(s) (or teaching teams) use television to raise the quality of teaching for students normally taught by all of the teachers in conventional classes? And (b), how can television be used to provide instruction where no teachers are available and where they may never be available? The latter question applies to two different conditions: One is the dispersed schools of small size in rural communities where the teachers lack training in special subjects like mathematics, sciences, and languages; the other is the more hypothetical condition where an institution, by using television, could admit more students than could be admitted without television and could thus provide educational opportunities for qualified students who would not otherwise be admitted to college.

Other questions relate to whether television broadcasts of instruction can be used to reach vast dispersed audiences of adults, to promote general education and to advance special and professional training. The extensive activities of the National Television and Radio Center, and the concept of the "video college" fit into this group.

The dramatic Continental Classroom and Stratovision School developments have been or are being launched as vivid demonstrations and practical tests of the extended uses of the distributive functions of television.

Finally, questions have been asked about possibilities of the cooperation of schools and other educational institutions of a region in sharing their best educational resources and extending their distribution advantageously. The Southern Regional Council has extensive plans for using television in this kind of role. Alabama, Florida, North Carolina, and Texas are experimenting with integrated regional instructional television networks. Similar projects are under way elsewhere in New England, the mid west and north west. There is increasing discussion of an emerging National Educational Television or fourth network. Such a development is well within the grasp of this "affluent society."

Let us return now to the questions of emphasis and give brief answers that have been supplied both by research of many kinds and especially by practical demonstrations.

1. Can teaching by television be done?

   The answer is an unequivocal yes. (1, 2, 4, 9, 10, 14, 15, 17, 18 & 26)

2. How can it be done?

   The answer is, in a great variety of ways: By closed-circuit and by broadcast (2, 8), by relatively simple as well as with complex equipment (1, 23, 30), with a wide variety of arrangements in originating and receiving rooms (1, 2), with single teachers and teams of teachers (4, 10, 23, 24, 35), with specially trained teachers and just good teachers (2, 30), with small groups and large groups of students (2, 26), both with and without "feedback" systems (2, 27, 28 & 29), with all grades and classes, and with adults (35), in situations with complex "professional" productions and with good "unrehearsed" teaching (2, 30), with a large number of different courses in which a wide range of teaching methods can be used (2, 9, 10, 14, 17, 23), and with simultaneous "live" and recorded delayed transmission (20).

3. What are the effects on learning of teaching by television as compared to a wide range of comparable conventional arrangements?

   Generally "no statistically significant differences" have been found. (1, 2, 18, 26) The differences plus or minus from this generalization are not worth arguing about.

4. What are the economy and cost of facilities factors?

With moderate cost closed-circuit systems efficiently operated, the break-even point in cost, per credit units of TV instruction, is 200 (plus) students compared with conventional methods (2). This is a straightforward management problem, and unit costs depend on volume, i.e., the number of courses taught regularly over a system and number of students in courses. A more valid product than credit units would be the net educational gain, if net gains could be measured.

Costs of systems vary from several thousand to more than a quarter of a million dollars. Estimated antiquation rate ranges from five to ten years. The general "image" of television is that it is very expensive and complex.

However, educational effectiveness appears not to be highly correlated with the cost and complexity of equipment of systems (2, 30).

Few systematic cost analyses of instructional television operations have been made (32). Others are needed on different kinds of equipment and operations based on realistic estimates of precise requirements.

5. Does the arrangement of having the "best" teachers instruct over television improve the quality of teaching?

The answer here is generally yes. (1, 35) However, released time to prepare instruction, the help of other members of the "teaching team," availability of teaching assistants and good logistical support of teaching sources are usually necessary conditions for improved instruction even with superior television teachers. Provision of those resources add costs which also need to be justified in terms of numbers of people served and the educational gains.

6. Can television be used to provide instruction to students who might not otherwise be taught?

The answer is yes, especially for rural schools (35). However, there are few instances as yet where increases in college and university enrollments have yet been demonstrably linked to the use of television except at the University of Houston.

7. Can television be used to provide appropriate educational programs for dispersed adult populations including professional groups?

Yes. This has been demonstrated in areas with credit courses in liberal adult education, teacher training, dental and medical post-graduate education as well as in the Continental Classroom Series. (7, 9, 15, 21, 23, 30 & 35)

8. Can television be used to consolidate and combine educational resources of a section, state or region?

This possibility has been successfully demonstrated in a number of major areas (6, 10, 35).

Many practical questions have been asked and answered first by relatively limited controlled experiments, and second, by extensive demonstrations and evaluated practical field tests of different arrangements for using instructional television. This very extensive educational development has probably been supported by more contextual research and extensive evaluations than any other comparable educational development in history.

Educators and administrators who have questions about practical, applied problems of operating and managing instructional television in its present stage of development can find both available and fairly adequate answers (3). This condition prevails largely because of the investments and leadership provided by the Ford Foundation (35). Subsequently, the Federal Government through the U.S. Office of Education under Title VII of the National Defense Education Law is supporting research in the general area on "new" media.

Just as the present state of developments in the area of educational television has not depended directly on controlled research, so too, major future expansions and applications are not very likely to depend on such research results. The function that carefully conducted contextual research has served in the past was to provide a sufficient level of confidence in possibilities for those responsible to proceed with extensive television developments and accept the risks of the results. Basic theoretical research has contributed little to these innovations.

We, in research, need to confront the cold hard fact that evidence yielded by basic research in the area of instructional television, as is the case in the field of educational research in general, is usually ignored in educational planning. It is true that much evidence in this area does not exist.

Demonstrations and evaluation by testing, which often gets classified as research, are more often sought and used, but even so, educational decisions are usually made on personal judgments, experience and copying of other known developments. In brief, research results are not very important determinants of decisions on practical educational problems and the planning of future developments.

Let us now attempt to clarify the position of research.

Certain activities which are important or even essential for limited local use should be integral parts of normal local operations; they should not be classified as research but as operations. Examples of these activities are: equipment selections, procurement and arrangements, cost accounting and actuarial statistics, conventional evaluations and assessments of instructional effects, management activities, intra-institutional and public relations, and finally efforts to resolve conflicts of local vested interests. These activities and their associated problems do not really belong in the general research realm to be financed by federal or foundation funds.

Another class of applied problems which has been solved sufficiently and even repeatedly, should now be viewed as a straight operational problem no longer deserving more than local research effort and expenditures. We do not need more demonstrations that conventional x, y, and z courses can be taught by television. The chances are that they or similar courses have already been taught successfully by television somewhere. Comparisons of results of teaching courses conventionally with teaching the same courses, in the same ways, by the same instructors, but by television, is a type of research which has run its course. Research funds and effort cannot be justified for convincing only the local skeptics to accept innovations. Ad hoc demonstrations that specified courses or other usual instructional tasks can be done through television may have local justification but if so, the work should be supported by local operating funds. There have been enough demonstrations that television can be useful in many supplementary ways in an extensive school system (10), city or region (35). Such projects can be justified as developments deserving of the support of those who will benefit from them, but no longer should they be considered as research to be supported by foundation or federal funds.

Many of the "how to do" problems have been studied enough to help those who are interested to avoid practical blind alleys. Complicated "professionalized" production techniques including elaborate sets, dramatic effects, "directed shows", etc., would appear to be artful luxuries in terms of limited effects on learning and intellectual gains (2, 21, 30). A wide variety of convenient and preferred arrangements can be used in originating instruction without importantly affecting results on learning. Sizes of classes or groups in receiving rooms are essentially unrelated to the usual and expected educational results (2). Proctors for the sole purpose of maintaining order in college classes are only justified for immature students who are not adequately motivated for sustained intellectual effort (2). However, classroom teachers are known to be necessary as part of teaching teams in most public school situations. Most of these problems do not require further research.

Where then is the deserved place of research in the broad area of instructional television? Where are the challenges? Where lie the risks for gains that justify such risks? Where are the problem areas of promise toward which research should be directed?

We shall now attempt to delineate some of these areas where various research efforts may yield gains in excess of costs and where results may benefit education generally.

V. Some Areas of Promise for Television Research

A two-fold task confronts us: First, areas of new research must be creatively and imaginatively conceived against a background of what has already been done in instructional television research and related fields. Additional background for conceptualizing and describing these areas should be provided by theoretical systems or hierarchies of hypotheses on the one hand, and important practical problems on the other hand. Second, the areas thus conceived and described must be judged, selected, and ordered in terms of their promise for yielding the most gains of the greatest significance on a national or international basis. This two-fold task is a formidable one indeed.

The problem of selecting from among a range of alternative research areas involves attempts to minimize risks and maximize gains. However, risks are always greatest for theory-oriented basic research where the prediction of results is most difficult. Risks are least for research which is directed toward the solution of practical problems, and where the possibilities of predicting results are good.

To describe areas of promising research is no assurance that the research will actually be accomplished. The formulation of hypotheses and the definitions of precise problems are important next steps. Designing experiments appropriate to the hypotheses, problems, subjects and context of the work are other steps. Securing or actually developing the instruments and resources needed for research will require additional time and effort. Executing the research strictly according to the design requires constant vigilance. Finally, there is the job of analysis, interpretation and reporting of results. In brief, the research cycle is long, and the description of promising areas is only the beginning of the cycle.

The following areas of judged promise are not necessarily arranged in an order of importance, productivity and urgency or in relation to previous research and current theory.

Area 1. Systems Analyses and the Determinations of the Place of the Media in Instruction

We suggested earlier that a systems analysis approach might be a desirable undertaking in the field of teaching and learning. The development of a model of the component operations of a higher order man-machine system focused on learning and intellectual development has not yet been done with the necessary rigor and thoroughness. Therefore, operational analyses of activities and functions which are component parts of delimited areas of teaching and learning appear to be promising areas for important research of this type.

The approach holds promise of contributing to definitions of crucial and important research problems. A systems analysis would reveal what we know and know with enough validity to build it into learning programs. It would point to the need for strengthening what we know about conditions and principles of learning as well as indicating how these conditions can be provided and the principles applied. When a total system of related and interlocking functions or operations is brought together and focused on learning, it can be expected that new problems will arise which are of a higher order of complexity and will, therefore, point to needs for additional and original research.

The systems analysis research should provide a basis for making decisions and testing their validity as they apply to the roles and functions of the new media in the total system or sub-system of a delimited educational enterprise. Questions about the appropriate uses of the media can be made more precise in the future. Rather than asking whether television can be used for teaching whole courses or even entire curricula the questions should be rephrased to ask more precisely what specific functions or operations are to be mediated by television to ensure the maximum instigation of academic learning.

Area 2. Mass Medium - Personal Learning

This research area encompasses families of problems and possibilities which arise from the capabilities of the general mass medium of television for transmitting large quantities of varied kinds of information, and for projecting and presenting this information to large remote audiences. The research area requires the development of guiding theories and principles for efficiently managing the informational distributive and regulatory capabilities of television and associated media. At the same time, it is imperative to satisfy the essential requirements for individualizing and personalizing instruction and learning. When a single common unit or program of instruction is channelled through television to large numbers of students or to a wide general audience, problems arise in adjusting this common instruction to all the variabilities which affect learning in the individuals. The level, complexity and especially the *rate* and *breadth* of the stimulus materials must be appropriately adjusted. In television communications the mechanisms for regulating the learning cue presentation and the necessary responses of students are very different from those that operate in person-to-person or instructor-to-student communications. The perceiving-responding student cannot easily and directly affect the quantity, range, level or pacing of the instruction. He cannot turn back units or segments of the television program for review as he can with the pages of a book or a "teaching machine." His problem is to attempt to comprehend what is presented, and to select from it those things which he should learn. In this situation a student may need new kinds of orientations or "sets" toward the tasks of learning. He may have old learning habits that interfere with learning from television. He may need to develop new skills of listening and of reading or scanning the faces of electronic tubes. The student may need to develop the ability to shift his perceptions rapidly to different sources of information or critical cues in the audio and video channels and in the various sequences of the program. He may need to comprehend fields of information and their ordered sequences. He may need new skills for assimilating information from different semantic levels as these are presented in given successions.

The mass medium-individual learning research area contains, for example, a series of problems on the remoteness-intimacy continuum. The perceived psychological distance of persons and sources of information may vary greatly in the judgment of different learners. What are the determinants of these individual differences in perceptions of televised instruction and what are their effects on learning under the varied conditions of televised instruction?

With television, how can the variables of reinforcement of correct responses and the extinction of incorrect responses be managed efficiently in common programs of instruction presented to large numbers of variable learners? How can we arrange for appropriate reward systems in instructional television? Finally, what extra-television activities and procedures are required in formal contexts and in school and college cultures?

There would seem to be two approaches that might be investigated relative to the adaptation of the *general* medium of television to the requirements of efficient individual learning. The first is to study how informational programs can be *optimally structured* and *temporally regulated*. The range of information and rate of presentation may be varied sufficiently to provide learning conditions appropriate to the known ranges of the individual differences of groups of students. The instruction could have a wide range of limits. The stimulus materials could be richer, broader and more varied than would be required by a homogeneous class or by a single individual and thus opportunities could be created for selective learning even for the most capable and advanced students.

The other approach would be to arrange for the desired homogeneity of classes or audiences of learners. By establishing optimum correspondence between instructional television materials and audience characteristics, can learning effectiveness equal or exceed that of efficient individual learning?

It should be observed that by describing this problem area as we have, investigators may be led to consider subject matter and teaching variables along with student variables as they interact and relate to learning (34), and to investigate the needs for supplemental and complemental opportunities for individualized learning.

Area 3. *Extrinsic or Intrinsic Motivation*

Research in the area of motivation seems to promise great gains in all educational endeavors. Motivational variables relative to learning of academic subjects are generally less well understood or controllable than the stimulus materials or information variables. Televised instruction accentuates the importance of the motivation of learners and this leads to the urgent need for research on understanding and controlling of the motivation of students to learn academic subjects. Some of the traditional motivating features may or may not be operative in televised instruction. For example, there are great changes in the interactions of instructor and student. In the usual teaching situation each knows and is known by the other, and there is an interplay of the personal roles and statuses of teacher and student with assessments and reassessments which are changed as work proceeds. There is the winning of approval, the gaining or losing of *personal* respect due to performance relative to mutually accepted or even imposed learning expectancy. All these factors operate differently in distributive televised instruction compared to the conventional small class, seminar or tutorial situation. Teaching by television introduces great changes in the reward systems that have been traditionalized in American schools, colleges and universities.

Television instruction needs intensive research to engineer means and methods for developing new patterns of rewards and motivation. Generally, it would seem that research could be directed toward shifting emphasis, to a greater extent than is true at present, from extrinsic to intrinsic kinds of motivation. We need to find ways of shifting responsibility from the teacher to students and rewarding the acceptance of this shift to students. We need to investigate the heuristic aspects of teaching and learning, to increase the intensity of students' personal satisfactions in discovering and exploring. We need to find ways to motivate students to conduct searches for the new; new words and symbols, new facts, new concepts, and new organizations of information. Relative to these forms of intrinsic motivating factors, the token rewards that we now use such as grades and credits are clearly perceived to be false and inadequate.

There is another area which needs to be investigated for televised instruction. How do we change the normative behavior of students so that positive reinforcements of academic learning occur forcefully in the network of peer interactions? In this way, students may progressively develop, both as individuals and as interacting peer groups, *an autonomy in learning*, and would be less dependent on the controls and regulators now manipulated by teachers.

A necessary concomitant in this area of research would be to study ways of developing in students skills of judging and assessing *their own learning gains*. Perhaps the vast array of tests and examinations represent to some degree substitute solutions to the more central problem of the personal assessment of learning and its direct subjective reinforcement. Perhaps what we should attempt to find through research are methods for developing in students a *conscience for learning*: the ability to judge and assess progress toward interiorized learning goals. If this can be accomplished then we will be closer to the *summum bonum* of having learning be its own reward. When this is accomplished then we shall have solved the problem of developing some factors of intrinsic motivation, and thus have circumvented some of the unsolved measurement procedures now thought to be so very necessary. In the meantime, until this is accomplished, research is needed to develop good instruments for measuring complex learning and for inventing ways to use television for administering tests and examinations to dispersed classes.

Area 4. Support of Program Quality

Instructional programs of high quality are very necessary for television. Research thus far points to two main determinants on the programming side of the system; the instructor and the course content and organization. It is toward these that research might be directed with some promise of improving the qualities of instruction.

Criteria need to be developed for selecting television teachers. Since we do not have well established and accepted performance criteria for good teaching, the general job will need to be done as specific criteria for television teaching are developed. The assumption that a good teacher in a classroom is also a good television teacher has received some support and has been a position of necessary expediency during the period of delicate recruitment and persuasion of faculty members into teaching over television. The opposite theory that the television teacher should be a skilled professional performer as judged by commercial and entertainment television standards needs to be carefully and critically examined. These standards may have some usefulness as criteria for superior television teachers. The possibilities are high that in large part new standards appropriate to instruction will need to be defined.

Television has in the past, and will in the future, require teams of teachers as well as individual instructors. Here we face the dual problems of selecting and training both individuals and teams, with each person being prepared for special jobs in the total system of television teaching operations. This is especially difficult because of traditions of individualism in the teaching profession and the pressures for conformist behavior on its members.

As the population of television teachers increases and these teachers are studied analytically, great differences among them are observable. There is some corresponding variation in the range of their effectiveness. The problem is to correlate differences in characteristics and performances of teachers with variability of effectiveness as measured by the learning of students.

Training programs for television teachers must be developed, and appropriate research should seek to answer what are the goals and requirements of this kind of training? What should be the content and methods of training and how can the special training be validated in terms of learned performances of students? Teacher training institutions are only beginning to recognize the problem but in many respects conventional teacher training is inadequate for this special problem. Indeed, in many instances conventional teacher training is antithetical to training for the use of "new" media.

Research is needed to develop specifications and standards for TV courses. At this stage the transposition of courses from the classroom, lecture hall and laboratory needs to be questioned. When we enter an era of inter-institutional teaching, regional educational networks, continental classrooms and the stratovision school, the development of courses to their maximum dimensions and full effectiveness becomes highly desirable if not absolutely essential. The expense, utility and educational values at stake in recorded courses which are widely used over considerable time would argue for making such courses superior in quality to those available even in our best schools and colleges. Research and development work is needed to learn how courses can be developed feasibly and effectively toward their maximum dimensions and qualities.

Area 5. Discovering and Overcoming Limitations to Teaching by Television

When highly qualified teachers, working as individuals or as teams, are available and are teaching highly developed courses through the full capabilities of closed-circuit or broadcast television systems, there are still limitations both on the distributive possibilities and perhaps on the quality of such instructional efforts. Supplementary teaching and learning activities are often required to achieve maximum results.

Several examples will help define this area of research: At Penn State eight hundred students could be taught English Composition simultaneously via television by a single instructor. Communication systems permit the instructor to call on individual students "at will." The limiting factor on the whole system is the impossibility of reading and correcting all of the weekly themes and holding the necessary personal conferences with students. Therefore, only one hundred and fifty students are being taught in the TV class even with the help of six assistants. In General Zoology five hundred and fifty students are taught regularly by one instructor with the help of a team of assistants. Several hundred additional students would register for the course and could be accommodated in television classrooms. The limiting factor here is that of laboratory space and facilities. In another general undergraduate course what is needed is the full competencies of several good instructors contributing in areas of their specialties. However, instructors often prefer their own advanced special courses and do not choose to work on a teaching team in a general TV course. Furthermore, students object to frequent changes of instructors.

The enrollment pressures which are developing in education could possibly force the teachers of English Composition to reduce or eliminate theme writing. The General Zoology teacher could possibly decide to eliminate the laboratory work. The general course may continue to be taught without benefit of the knowledge and skills of advanced specialists. We need to know whether or not such adjustments to these and other limitations will affect the quality of instruction.

Research of an appropriate type is needed to define actual and possible limitations on the extended use and quality of televised instruction. Having defined the limitations, research is then needed to plan for and evaluate the possible alternative solutions to the new problems introduced into the system by television.

Area 6. Research on Combinations of Media

Television was described earlier in this paper as a general medium, in the sense that most other media can be used through television. Can the characteristics and potentials of other media be mediated completely by television? And what are the characteristics of television which, when imposed on other media, reduce or increase their effects on learning?

The objective of research in this area would be to determine the characteristics of models and patterns or combinations of media for use in different kinds of teaching-learning situations for different kinds of context. What potentials of sound motion pictures, radio, kinescopic, video tape recordings and graphics can be combined to summate their effects and impacts on learning? What guiding principles and hypotheses do we have or can we derive for this job? What kinds of functional analyses are needed in order to construct and test full potential models of combinations of media? What are the learning requirements that are difficult to satisfy with the "new" media in their present stage of development and what modifiers are needed when they are used in combinations or as a total system?

What are the possibilities of single as well as sequences of "concept" films, i.e., short films that develop, illustrate, elaborate, and generalize single concepts? These films apply single cohesive concepts which are repetitive but also varied and may instigate as much learning when presented to students over television as by individual "teaching machines". (11) Indeed, can the essentials of the operations of "teaching machines" be built into programmed instruction and presented over television? What are the possibilities of film loops which require participation or response, are repetitive and provide knowledge of results? Is it possible by skillfully combining the teaching media to produce infrangible learning?

The challenge of the research area on combining media for maximum effects on learning would be great because it would be necessary to bring all that we know about all the media into focus on an interlocking network of problems. In addition, when patterns or combinations of media are tested, new research problems and the need for new research methodologies will surely be revealed.

Area 7. Development and Communication of Models of Mediated Instruction

The central problems of this area are concerned with how to make significant changes in educational methods and procedures, and how to gain the acceptance by educators of new technologies of communications, like television, for use in instruction. The problems of innovation are well known; their solutions may be advanced if appropriate and valid research results are communicated effectively to the decision-makers for schools, colleges and universities.

The method consists essentially of designing, building, operating and assessing working models of the new media in realistic contexts. The models are then vividly and realistically demonstrated to those who make the crucial decisions about the acceptance of innovations in instruction, especially the controllers of funds and other resources but, also, those who decide about curricula and methods.

There is precedence for the approach that is being suggested. For years we have used experimental farms and experimental stations in agriculture. Sporadically, we have built "model" schools. We demonstrate new models of computers, cars, aeroplanes and missiles. Even instructional television models have been used extensively. For example, the Penn State model has been visited by several hundreds of educators and the Washington County, Maryland model has been viewed by several thousands. These models are types of communications which have potentially high effectiveness both for informing and convincing people of their usefulness.

These models may represent the culmination of a long series of events: Theoretical systems, pure and basic research, research and development, equipment designs and fabrication, engineering trial-and-error and proving ground tests, and finally the finished product which can be observed by specialists and by non-specialists alike to satisfy a defined need or function.

What we visualize are models which incorporate research results with the media and which can be demonstrated to meet an educational need in realistic tests and under realistic conditions. What we propose is that programs be planned for using functional and realistic models as one means of communicating information about "new" media, new practices and research results. Furthermore, we suggest that the media like films and television be used appropriately and to the fullest extent to communicate information, including research results, about the models to decision makers in education, to large numbers of professional teachers and to the general public. A wide range of research could be done on the model installation and operation as a medium of communications directed toward introducing new technologies into educational systems and institutions on a regional or national basis.

This would be action research of a high quality and may accomplish what written reports alone fail to do.

VI. The Logistics, Strategy and Tactics of Research

It is suggested that a subsequent conference should consider the subject of the logistics, strategy and tactics of national programs of research in the field of communications and particularly in the area of education employing the "new" media.

In engineering, an annual conference of leaders in the administration of research has been held informally for over twelve years. Nothing like this has occurred in the field of communications and media research or indeed in any areas but the "hard" sciences.

This important field of communications research, qua research, is largely unorganized and undeveloped. Numerous projects and programs in the area of instructional media were initiated, began to take root, showed promise for a period and then died. The Instructional Film Research Program at Penn State was one example of this relatively short life history cycle of media and communications research. There are many other examples. Later, after termination of the programs, it could be observed that the continued flow of research results and trained personnel which such programs were yielding are urgently needed. Then, large expenditures of energy and funds are necessary to reactivate needed programs of research.

Periods of crisis and critical issues arise which, in part, depend for their resolution on educational and communication technical resources effectively used, and on new knowledge and approaches which can only be produced by sustained imaginative research. Unfortunately, there are very few examples of such sustained research in instructional communications. Nevertheless, events move inexorably and the crises and issues are usually resolved in a haphazard fashion without the benefit of research counsel or of the new information that might have been available. Time lost is gone forever.

At any given period we might have important lines of research in progress which desperately need financial support. Without such support, organizations are dissolved and their staffs dispersed. At another period funds might be available but there may be shortages in qualified people to invest the funds in research effectively.

The conclusion is clear. We need to consider the logistical problems of providing both adequate and sustained support for important lines of instructional communications research. One of these lines surely is research on the mass media and other new technology applied for solving educational problems. In this area we need to understand and use broad strategies of research and the tactics required to accomplish desirable research objectives.

A promising possibility would be to build, institutionalize and insure the continued operation of several educational communications research centers. This country, this "affluent society" can well afford five or six such centers. They should be appropriately housed and well equipped with the special apparatus systems which are essential to high quality and advanced research on communication processes and problems related to education. For each center an adequate core staff should be built, trained and developed. The numbers of the core staff should have permanent tenure and assurances of continuing support by the host institution, by foundations and federal agencies in order to be able to conduct systematic and programmatic research. By planning and by agreements the centers could investigate different phases of basic general problems in depth and could undertake special projects appropriate to the interests of personnel, facilities, populations and the geographic location. Finally, reasonable coordination could be arranged among the different centers. Lines and programs of research could be conducted in the special centers which were appropriate to their characteristics and with full knowledge by other centers of what was being done there. Replication of research could be done when required but expensive duplication of work could be avoided. Furthermore, the programs of the centers could be coordinated with individual research projects of the area. Indeed the strong centers might after due time stimulate the increase of individual projects and raise their research standards and quality.

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THE USABLE RESIDUE OF EDUCATIONAL FILM RESEARCH

By Charles F. Hoban

Dr. Hoban, Research Professor of Education, and staff member of the Annenberg School of Communications, at the University of Pennsylvania, is also co-author of the first extensive review of instructional film research. Here he takes stock of the long history of research in films as teaching aids.

I. INTRODUCTION

In generalizing research findings, or, for that matter, in dealing with them on an individual basis, it is necessary to make criteria of confidence explicit. Otherwise, acceptance or rejection of research findings is likely to be based on what Whorf (28) calls "natural logic," i.e., a series of implicit concepts or propositions which admit of no alternatives, explanation, or explication.

Furthermore, a working definition of scientific method is also essential since a philosophy of science, frequently that of logical positivism, underlies the great emphasis on empiricism as such in film research. Respectability in film research is equated with the controlled experiment, and thereby restricted. The controlled experiment is equated with science. The product is an implicit concept of scientific research that needs to be made more explicit. This can be done by defining scientific method.

Under the circumstances, it is appropriate to look to a living philosopher for a definition of scientific method. Nagel (20) supplies one which, at first glance, seems to pronounce a benediction on the narrow empiricism of data-gathering researchers:

> ...what is distinctive in all science, not merely of natural science such as physics, and what assures the general reliability of scientific findings, is the use of a common intellectual method for assessing the weight of the available evidence for a proposed solution of a problem, and for accepting or rejecting a tentative conclusion of an inquiry. Scientific method, in my use of the phrase, is a procedure of applying logical canons for testing claims to knowledge.

This broad definition provides both a contrasting background and a source of some support for the criteria used in this summary of educational film research findings. It is to be understood that this summary is an attempt to state current policies of knowledge in the field. Policies of knowledge are propositions suggested by systematic observations of behavior, subject to revision suggested by additional observations, or by alternative imaginative constructions suggested by the same or additional observations.

The policies-of-knowledge concept is used so as to avoid intellectual booby-traps intrinsic in the use of such words as *facts*, *truth*, and *science*, and in the imputation of invariance and absoluteness by such words as *laws*, *principles*, etc., superimposed on summaries of research findings.

In educational film research, we are dealing with a finite body of material produced during a finite period of recent time during which theory, research technology, and the art of film-making have changed and expanded. It is, thus, necessary to formulate criteria of confidence that are realistic in terms of research material at hand. Furthermore, the criteria employed must be formulated so as to be useful in terms of decisions that must be made within the limits of risk tolerable in an ongoing process of education *under bureaucratic control* (a) in directing and controlling future research activities, (b) in educational television and other media or teaching devices as well as educational film research.

Those among us active in educational programs are acutely aware of some facts of life that we, as research-oriented individuals, might prefer to sweep under the rug. One of these facts of life is that formal educational programs frequently do not rest on firm theory, supported by immaculate research data. Consequently, a policy of knowledge based upon reasonable theory with even tenuous research support is likely to be a basis of decision as good as the current one, if not better than it.

It may be argued that consideration of the decision-structure of formal educational programs is totally irrelevant to, if not a deliberate subversion of, the *ad hoc* task of this seminar. If we were operating in a field of pure science, such an objection might have considerable validity. But educational research, by virtue of its qualification, is not a pure science field. It is, quite patently, a field of operationally-oriented or applied scientific research.

A. *Criteria of Confidence*

Four criteria of confidence are used in generalizing the substantive findings of educational film research. They are not limited to the application of "logical canons," yet they do not deny the validity of what Nagel proposes. While these criteria are my own, I believe they are or resemble the *de facto* criteria by which certainty is assigned to educational research findings in the present "state of the art."

1) *Reasonable intuition*. Essentially, this criterion specifies that if "facts" (meaning numbers and statements about numbers upon which statistical operations have been performed) conflict with what is intuitively reasonable, the "facts" are suspect. It is immediately granted that, by this and other specified criteria, confidence is *subjective*. I can't imagine what else confidence can be, although I recognize that, among other things, specified "confidence limits" indicated by mathematical probability influence confidence.

2) *Demonstrated competence of the investigator as an imaginative observer* in the field of psychology, sociology, education, communication, or a related discipline. Nagel supports this criterion. He asserts that scientific concepts "have not been obtained by a process of simple abstraction from empirical data, but that they are intellectual creations, often *suggested* by the data, and are the products of constructive imagination." Hence, subjective confidence in research findings is related to the

demonstrated competence of the researcher as a constructively *imaginative* observer, not blinded by his "hypotheses."

Some of the "best" leads to policies of knowledge in the field of films in education come from imaginative explanations of phenomena which competent researchers carefully warn us are observed in "exploratory" experiments involving "crude" concepts, techniques, and appurtenances. Yet, as Merton (19) points out, "in observing particulars we inevitably imply universals."

Constructively imaginative insights applied to "crude" data, that may in themselves fail to satisfy the rigorous test of Nagel's "logical canons," are at least a *source* of advancement of policies of knowledge.

3) *Relatability to a consensus of theoretical formulation.* Lonesome data, random points on a grid, and *empirical* research findings are of little use unless and until they are related to a systematic formulation which, by consensus, is accepted as a theory. Confidence in the generality of research findings is enhanced when research findings are or can be related and integrated into an accepted formulation of higher order abstraction. Conversely, confidence in the generality of research findings is weakened when they are not explicitly related, or relatable, to such a systematic formulation, i.e., to theory. Film research has notably avoided theory-orientation.

4) *Replication of the investigation of the problem* adds to the confidence in results, provided that the results of replications are consistent or extensive. In replication, neither the stimulus (or input) ensemble nor the techniques of investigation nor the population characteristics need to be identical. There is really no point to complete identity in replication of a study, except to satisfy the human need for redundant information. Nor, for that matter, is complete identity in replication likely to be achievable with human subjects. Replication involving a relative rather than an absolute constancy of the experiment is essential to increase the generality of the findings beyond the unique conditions of any experiment. This criterion of replication leaves open the questions of how many replications there are and how varied the conditions are. The answers to these questions are functions, in part, of the individual's tolerance and criteria of risk, and these probably are related to his "personality characteristics." Subjectivity appears to be inescapable.

B. *Case Illustration of Criteria Application*

The application of the criteria of confidence can be illustrated by research findings on the effects of color vs. black and white films in factual learning.

Intuitively, the expectation of a difference between educational effects of color and of black and white films is reasonable. Color is a visual dimension. A dimension can be equated with information so that a one to one relationship can be said to exist between the addition of a visual dimension and the addition of information. Under conditions as yet unspecified, it is intuitively reasonable to expect that the addition of the dimension of color to a visual presentation will increase learning, including factual learning, since, in information theory, information is valued in terms of its reduction of the range of alternative sequential events. Learning involves such a reduction, and, if one chooses, can be defined in such terms.

Imaginative researchers have investigated, with replication in variety, the problem of factual learning from color vs. black and white films. In general, the results indicate either no significant difference, or internally contradictory results such as that with some films color is significantly superior and with others there is either no difference or a difference in favor of black and white.

We are thus confronted with a situation in which the "facts" do not coincide with reasonable intuition. Without being able to relate research findings, i.e., the "facts," to a theoretical formulation, we have only two alternatives: 1) to accept the policy of knowledge that color films (vs. black and white) add no significant increment to factual learning, or 2) to continue researching the problem by increasing the number of combinations of color with "subjects" of films, population samples, test items, etc., etc. Neither alternative is acceptable. Thus, we are forced to look elsewhere for resolution of facts and intuition.

In 1957, Neal E. Miller (17) set forth a series of "scientific principles for maximum learning from motion pictures" in which he related film research problems and findings to his drive-cue-response-reward theory of learning. Miller's treatment constitutes one of the major advances in a field notable for its rule of abstinence from major advances, its dreary plateaus of conceptual confusion, and its preoccupation with ad hoc problem formulations.

In his discussion of cues, Miller points out that "Color should be an advantage if it is one of the most relevant cues or can be used to emphasize relevant cues; it should be a disadvantage if it distracts or complicates." This deduction from Miller's theory of learning (by no means completely reported in this particular discussion) provides a handle by which we can begin to deal perceptively and usefully with the problem of color vs. black and white films (and of ETV of the foreseeable future).

Since the "facts" revealed by research are not consistent with reasonable intuition, and since little if any attempt was made in most of the research studies either to define the problem or to analyze the data, making it relatable to theory on which a consensus exists, our confidence in the research "findings" diminishes. In justice, if not in charity, it is clear that we are more likely to find "right answers" by asking "right questions." Adequate initial conceptualization of the problem, or later insight into it, is a necessary condition for asking the "right question." This is so, even in what may be designated as ad hoc or applied research.

II. AVAILABLE SUMMARIES AND UNWELCOME REIFICATIONS

A. Available Research Summaries

The existence of several summaries of film research "findings" eliminates the need for an encyclopedic approach to my task and for a bibliography of film research reaching or exceeding 400 items.

Hoban and van Ormer (9) summarized instructional film research up to 1950. In the nine years since then, research on educational films has added to the scope and the conceptualization of film research and to the constructions attached by Hoban and van Ormer to research findings up to 1950.

The "progress report" of Hovland, Janis, and Kelley (10) on psychological studies of opinion change is important more for its conceptual than for its definitive research contributions. The idea of a summary and interpretation of existing research as a "progress report" is so self-evident that one wonders why this idea was not prominently articulated and accepted long ago.

The report-of-progress idea is echoed in the May and Lumsdaine (16) report on Yale studies of educational films issued last year. The May and Lumsdaine report deals exclusively with films. The Hovland, Janis, and Kelley report deals primarily with communication and persuasion. Within this conceptual context, Hovland, Janis, and Kelley apply constructive imagination to data and lack of data on "credibility of the communicator," "fear-arousing appeals," "group membership and resistance to influence," etc. In the opinion of your present "progress reporter," this sort of conceptualization is an intellectual bench mark whose existence and importance has, to a large extent, been overlooked in research in both films and TV in education.

Fearing (8) uses even a broader orientation in his discussion of the "Social Impact of the Mass Media of Communication." While Fearing's chapter is largely concerned with research relating to the impact of films, radio, etc., in out-of-school exposure situations, many of his observations and conclusions are relevant, or appear relevant, to the use of films (and other modern media) in the formal curriculum of school and college.

Miller's (17) summary in terms of learning principles has already been cited. Because of its orientation, this summary is highly selective within the range of film research studies and includes non-media studies on the psychological mechanisms or phenomena discussed.

The 1960 edition of this Encyclopedia of Educational Research will contain such a summary, through 1958, by William H. Allen. This forthcoming article, supplemented by a limited-circulation mimeographed version carrying the research through 1958 (1), reflects the trend toward an increase in the evaluative treatment of educational film research.

The research summaries by Allen; Miller; Fearing; Hovland, Janis, and Kelley; and Hoban and van Ormer by no means exhaust the list of such summaries. They merely indicate that many summaries of research have been made and are available.

B. Classification and Reification of Media

It might logically be expected that "devices" such as motion pictures, television, etc., would act as integrators of the conceptual and research approaches of the several disciplines related to (a) device development, (b) the input or output of the device, and (c) the responses of the audience. In practice, however, this expectation has failed to materialize. Instead, a device tends to result in reification of the "power" of the device.

Statements made about films in education are statements about the combination of (a) undescribed and uncharacterized information, represented pictorially, with or without the addition of information expressed in linguistic or in non-linguistic sounds, with (b) a technology of information storage and display. The statements are neither about the information stored and displayed nor about the content, rhetoric, or syntax of this information.

Reification is neither a *malum in se* nor a *malum prohibitum*. What is dangerous, if not insidious, about reification is the likelihood that it will not be recognized or dealt with for what it is. It is understood that, in this summary, "film(s)" represents a classification of an aggregate of informational content, presentational treatment, and projection techniques and devices. The use of the term is a matter of convenience and nothing more.

III. SUBSTANTIVE RESIDUE OF RESEARCH FINDINGS

It would be nice to be able to reduce the application of the criteria of confidence or research findings to a formula in which the nature of the interrelationships and weighted values of the four criteria were clearly specified. Since this is not feasible, the alternative is that of a gross scale on which the zone of high certainty corresponds to an achievable consensus that all four criteria have been satisfied, and the zone of low certainty corresponds to a similar consensus that two or less of the criteria are satisfied.

The zone of intermediate certainty lies between these two extremes. Since the criteria are subjective, border lines between zones are not sharp, nor is there any need for precision or boundaries.

A. *The Low-Certainty Zone*

Within the zone of low certainty, as within the other two zones to be summarized, gradations are implicit. No deliberate attempt is made to indicate the gradation between limits of this zone, or the other two zones of certainty.

1) *The network of communication of research findings.* A serious vacuum in educational film research (as in most of educational research) is in the investigation of the network of communication of research findings from investigator to implementer. Film research, like any research, is a production enterprise. The product is information. This information is distributed, partly through the channels and procedures of technical reporting, and partly through the interpersonal grapevine. There is little evidence that film research findings have reached and influenced the producers or users of films for and in schools and colleges.

One suspects that the researchers have tended to avoid contact with the retail market -- easily understandable behavior on the part of highly trained specialists who have narrowed their activities in communication to specialized study in preference to the more exacting role of distributing the results of their study to user groups other than their professional reference group. Marketing film research findings to implementers is a tough and time-consuming job for which researchers may have little aptitude or training and less time (cf. 8). However, refusal to study the marketing problem, particularly the network problem, is a research neglect, for which a heavy penalty is paid in social efficiency.

It is interesting that the network problem involves the integration of so many elements (or components) of communication. A point of departure in network research is Christie's (4) definition of a network as the "rules of permission and prohibition on the routing of messages." Presumably, this definition is not intended by Christie to be sufficient or comprehensive. He uses it in his study of the structuring of information processing in task-oriented small groups. However, the concept of a network as a set of rules of permission and prohibition on the routing of messages is quite generally useful. From this point of departure, the problem expands to include sources and receivers, channels and media, the character of the information and the transformations it undergoes, the movement of messages between people in time and space, and the responses to the routed messages. Essentially, this is the macrocosm of communication.

The vacuum in research on the network of distribution of audio-visual research information constitutes one of those sealed-off areas that perpetuate in the intellectual community what Bateson (2) terms *schismogenesis*, i.e., self-perpetuating esoteric groups whose members talk only to each other, and accept as novices only those who conform to group norms in values, motivation, temperament, and ability (cf. 17). *Schismogenesis* is a built-in mechanism for increasing what most of us blandly call "cultural lag" and tend to accept as an inevitable social evil.

2) *The rhetoric of pictorialization.* The rhetoric of pictorialization is old-fashioned rhetoric applied to the medium of pictures. Old-fashioned notions of narration, exposition, description, and argumentation specify the forms of rhetoric. The analytic study of these forms has been neglected although study of films involving one or a combination of these forms has been made since Lashley and Watson (14) conducted the first comprehensive evaluative study of a film. In this study, published in 1922, the evaluated film was dramatically structured, characterized by exaggerated naiveté of plot and conflict resolution.

The Lashley-Watson study is a classic in the sense that its analysis of the problem, its indices of results, and its basic findings antedate conceptualizations rediscovered or reformulated in the late 1930's in studies of social impact of the mass media, and increasingly used since then.

The rhetorical problem is an extremely complex one. Were it not for the fact that application of old and new techniques of scientific inquiry is yielding data in areas hitherto thought unresearchable, one would be prone to conclude that the complexity of the rhetoric of film treatment is such that this problem area can only be nibbled at, not systematically investigated. Furthermore, various investigations of "appeals" in communication have yielded results that generate optimism toward appeal-analysis as one of several ways of coping with the problems of film rhetoric in research. Rhetoric may then be defined in terms of efficiency of display of an appeal.

A rather long quotation from the report of Lashley and Watson on the appeal problem, and on the responses of audiences to these appeals, seems justified for more than its historical interest.

> One of the first points with which we were impressed in our study of the picture was its failure to make any appeal whatever to well-informed men and women. Lacking

> the interest of new facts for them, its literary defects overshadow all else. It was attacked by them as crude, inconsistent, tedious, maudlin, and it failed to hold their attention. This at first appeared to be a serious defect in the film, but as we observed its effects with larger and more ignorant audiences, such criticism seemed inconsequential. For the vast majority of people, even among cultured classes, interest in the facts presented and *in the story*[*] is intense and its inconsistencies are not noted. Sentiments which were ridiculed by the medical and similar groups were applauded vociferously by the car men (transit workers), soldiers, and others, and comments in the questionnaires, as "I'm like Bill," show frequent identification with the hero. In the criticisms of the sex-hygiene pictures there is not infrequently the suggestion that the critic has failed to consider this class distinction and that no small part of his criticism is a rationalization of his own revulsion against the "drivelling inanity" of the story.

Various research studies since 1940 suggest that dramatic story treatment has little, if any, advantage over less theatrically ambitious rhetorical forms in instruction in factual learning or in changing attitudes or overt behavior. However, the technical difficulties of inter-treatment study alone are so formidable that the problem has not been adequately researched.

As indicated above, reasonable intuition (illuminated by trends in motivation research, studies of persuasion, etc.) argues for a partial reconception of the problem of treatment from that of form to that of the dynamics of thematic appeal and audience characteristics. Even were the dynamics of appeal to be sufficiently clarified, the problem of integrating appeals into a structured pictorial presentation remains. Film research has not faced this problem head-on. Consequently, the rhetoric of film presentation lies in the zone of low certainty in our current policies of knowledge. The rhetoric of films in teaching remains an important and relatively an inadequately explored problem of instruction. This problem is not confined to films. Considered on the level of semantic effects, it extends to all media of communication.

3) *The role of pictures and language*. The focus of film research during the 1930's on sound vs. silent films was device-determined. Sound film introduced a more complicated technology, and, with it, commercial obsolescence of silent films in education.

Various research studies before and since have shed little light on the differential and interacting roles of pictures and language in films. Without a fundamental understanding of the roles of each medium, it is difficult to deal with the problem of best employing both of them, simultaneously or sequentially. Yet, this is what must be done in practice with illustrated books, titled or sound film strips, motion pictures, and television.

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[*] Italics mine.

Several research studies have suggested a synergistic relationship among the various media of communication. This contrasts with the rivalry of print and pictures diligently cultivated by humanists in their struggle to preserve what they have long considered to be their apogee status in the intellectual and academic world. Rulon's (22) study, discussed in the following section, suggests an interaction of films and reading. Other studies suggest that titles on "projective" pictures influence the interpretation of pictures. Still other studies suggest that the value structure of prejudice is sufficiently salient to produce a reverse response to the anti-prejudice intensions and efforts of the pictorial (*cum* verbal) information generators.

A lonely and somewhat apologetic report by Harris and Buenger (7) of a pilot study of learning from film and from lectures provides what may be a "first" cue in research to what several philosophers and many doctrinaires in audio-visual education (communication) believe to be an essential inter-media difference. This belief has recently been reformulated in a challenging cryptic of McLuhan: "The medium is the message." McLuhan (15) is a brilliant disciple of Innis (12) whose rate of idea generation is so great that, by chance alone, some pregnant insights are predictable.

Harris and Buenger investigated the magnitude and significance of correlation between tests of learning from films and tests of learning from lectures (and related verbal materials). They found a low-magnitude, non-significant correlation between the raw scores, and a low-magnitude significant correlation between souped-up ("adjusted") scores. It is, of course, possible that the obtained correlations are, at least partly a function of the tests, or that they may be a function of rhetorical differences of presentational treatment between the films and the lectures.

It is, perhaps, grasping at straws to attempt to relate the findings of the Harris and Buenger pilot study to theoretical (philosophical) formulations of media characteristics. Nevertheless, the data obtained in their study *suggest* (as all data only suggest) that media differences may exist and may be empirically verified.

In connection with the problem of role of picture and language, it serves little purpose to enumerate the various studies of effects obtained by applying readability constructs to film commentary, by using an obtained optimal rate of words per minute of sound track narration, etc., other than to acknowledge publicly the diligence of researchers in dealing with the language component of audio-visual messages. Differential roles remain to be identified and explicated in or by research. Since only two criteria of confidence (reasonable intuition and some consensus of theoretical formulation) have been satisfied, confidence in policies of knowledge in this area is extremely low.

4) *Films and the higher mental processes*. Film research to date has been a feast of investigation in factual learning, in attitude change, and in perceptual-motor learning, and a famine of investigation in what has long been referred to in educational psychology as "the higher mental processes." By "higher mental processes" are meant those rational activities unique to man -- conceptualization, critical thinking, generalization, etc.

For reasons not difficult to imagine, this area has escaped major attention in research on educational films. The influence of Judd, Tyler, Brownell and others nurtured in the Judd and Charters tradition seems to have by-passed the concern of most film researchers.

Two research studies, one by Rulon (22) and the other by P. E. Vernon (26) take higher mental processes into account. In Rulon's study, "rote" items were distinguished from "eductive" items. "Eductive" items are those which require that a concept be applied to a "new" situation, or that one "fact" be inferred from another. Rulon found that when films and textbooks were combined in the instructional program, significant differences obtained in favor of the "eductive" over the "rote" items. The differences held for immediate and delayed (3 1/2 months) tests.

Vernon studied film and film strips in teaching British seamen in World War II to take soundings. It is a sheer delight to read his report after wading through the ponderously objective ones of American researchers. He found that greater gain from film and film strips obtained in "comprehension" scores than in "memory for detail" scores.

This ends the research tale of films and higher mental processes. It is noted that a synergistic effect is found in both the Rulon and the Vernon studies.

Intuition, combined with theories of the meaning of meaning, strongly indicates that higher mental processes are influenced by films, and research data weakly suggest that a synergistic mechanism of some sort may operate to increase this effect. However, according to the research data at hand, the relation of films to responses involving the higher mental processes remains in the zone of low certainty in policy of knowledge.

B. Zone of High Certainty

In dealing with those film findings that satisfy the four criteria of confidence and thus fall in the zone of high certainty as policies of knowledge, it is necessary to make a distinction between policy statements and the successful use of stated policies in specific teaching programs. The former is a product of scientific inquiry. The latter is a product of the "art of teaching."

Like all arts, the "art of teaching" is highly creative in many respects. So are the arts of film-making, television, production, and other activities having to do with the production of a product. The creative nature of film-making increases the difficulty of film research, since (a) independent variables are embedded in an art-form, and (b) the art of film-making itself is a variable. In the creative process, the artist, knowingly or unknowingly, may introduce additional variables which have not yet been identified as variables in theory or research. Consequently, there is a consensus rather than an invariance in film research findings supporting the relatively certain policies of knowledge, in that "pure" research in educational films is practically impossible.

The following formulation of policies of knowledge in the zone of high certainty may seem to be unduly conservative. To be sure, it is frequently much easier to specify areas of ignorance or near-ignorance than areas of certainty. However, in dealing with high-certainty policies of knowledge, only two alternatives appeared to be open: (a) to specify an unwieldy number of specifics on which all four criteria of certainty have been satisfied, or (b) to generalize broadly enough to include the large number of specifics in a few general statements. The latter alternative was chosen as the more manageable, though the less detailed.

An integrating structure has been lacking in film research. Education has no rigorous theoretical basis or useful vocabulary (in contrast to jargon) into which film research can be integrated. Psychology is still in the process of continuing proliferation, and its technical vocabulary is still cult-oriented. Sociology has contributed the concepts of role, prestige, status, and group identification, but these do not satisfy the full spectrum of requirements for adequate research. An available source to which we can turn for integration is the theory of structure and dynamics of communication (cf. 24).

In the following discussion, some of the concepts and tools of communication theory have been selected and applied so as to bring some kind of order into the statement of policies of knowledge consistent with film research findings. This attempt is severely limited by both the research material and the assigned scope of this paper.

1) *People learn from films*. This policy is axiomatic, and it may appear fatuous or obvious, or both. It need not be explained here why so much film research has been devoted to producing empirical data in support of the self-evident, and larger absolute quantities of educational television research are being spent to the same end. Nor need it be explained that media research in education frequently deals with comparative learning, i.e., with the problem of whether the learning increment from newer media and methods is equal to, less than, or greater than that from older media and/or more conventional methods. Fundamentally, concentration on these research problems is a function of the process of innovation in education -- a process to be discussed briefly in a later section of this paper.

A tremendous amount of film research has been in the field of learning. As a result, the evidence that factual, attitudinal, opinional, and perceptual-motor learning occurs when people are exposed to films is overwhelming. On the basis of satisfaction of all four criteria of confidence, it can safely be said that people learn from films.

Instead of disposing of the problem, this statement of a policy of knowledge opens up the question of the determinants. It is in the nature of man to learn. The central problem of education is not learning, but *the control of learning*. Once we have satisfied ourselves that people can and do learn from films, the problem becomes that of (a) controlling *what* is learned and (b) increasing the *efficiency* of learning.

2) *Learning from films varies in amount with audience characteristics*. Despite the observation by Lashley and Watson reported in 1922 (14), the importance of audience characteristics as a determinant of learning from films has only recently come to be appreciated and forcefully articulated.

Since we are discussing audience characteristics *per se* in the zone of certainty, we need not explore the range of audience characteristics that have been investigated in film research or suggested by film research findings. These have been spelled out in detail in the Hoban and van Ormer summary and have been only slightly extended in research studies published since 1950.

Two significant parameters of audience composition on which there is little room for disagreement are age and amount of formal education, even though there are upper and lower limits beyond which little or no research evidence exists and few noticeable differences may intuitively be anticipated. In general, a difference in amount of learning from films can be detected between elementary and high school students, and within as few as three grades in the elementary school.

From his study of film research findings, Fearing (6) has concluded that ambiguity is a function of the audience. This is a remarkable insight. It transfers (in the sense of sharing) to the audience a characteristic of information hitherto assumed to be uniquely or predominantly a function of presentation and thus assumed to be controlled or controllable at the source rather than at the receiver end of the communication transaction.

3) The amount of learning from films can be increased by the use of mechanisms and methods, either built into films or applied in their use.

(a) Redundancy. This is one of the fundamental means of communicating information for which the sense organs of the body, particularly the eye, seem to be constructed. Furthermore, redundancy seems to be a requirement for human certainty of information. In research-supported theory, it is a most generally effective determinant of learning.

Essentially, redundant information is repeated information. Applied to learning, redundancy means the same as repetition.

The relationship between redundancy and learning has been shared in human insight and acceptance for centuries. At least as early as the time that Pompey stormed Jerusalem and entered the Holy of Holies, sword in hand, to emerge in bitter frustration at his failure to find a tangible Image of God, the Hebrew word for learning was also the word for repetition.

Ironically, the communications engineer and the information theorist take a dim view of redundancy, and try to minimize it in order to increase transmission efficiency. Similarly, the English teacher in high school and college frowns on redundancy, identified as tautology, and expends considerable effort to teach students to avoid it in formal writing assignments. All in all, the use of redundancy in communication is an uphill fight.

For one reason or another the history of film research is the history of intense research activity on the effects of redundancy in learning from films. Repetition of whole films, repetition of scenes and sequences, repetition of illustrative examples, repetition in films and film strips, repetition in review and discussion of film content -- all these have been investigated, and, in general, all have resulted in increments in learning.

(b) Participation. This term is used because it has been extensively employed in film research. In this usage, it means student activity during a film showing -- answering questions inserted in a film, or some variant of this overt exercise within the timed context of a film showing.

A preferred term is practice. It is broader, and hence includes a greater variety of student activity related to learning what the film is intended to teach.

The practice concept is both a particularization and an extension of the Corey-Dale (5) axiom that "children learn what they do."

Mental practice, tying a knot during a film on how-to-tie-a-knot, answering questions asked in the film -- all these and more forms of practice have been investigated in film research. With the exception, for instance, of the finding that practicing knot-tying is not helpful during the showing of a film in which the rate of presentation is more rapid than the rate at which students can observe and practice knot-tying, the research results are consistent with intuitive expectation and a consensus of theoretical formulation. They indicate that participation, i.e., practice, increases the learning of what is practiced.

For some time, there was conceptual confusion in film research as to whether participation involved motivation or practice, i.e., whether it increased the student's motivation to learn, or whether it provided practice exercise of relevant responses. Recent research indicates that the practice effect is dominant.

The participation techniques studied in film research are closely related to feedback information on performance. Educational research has long since established the effects of knowledge of results in learning. When knowledge of results is added to participation, or otherwise incorporated in the methodology of film use, an increment in learning is generally observable.

Due to its emphasis in communication theory, Wiener's "cybernetics", and other relatively recent intellectual developments, the term feedback seems to be preferable to the term, knowledge-of-results. By definition, "cybernetics" is the science of control (government). If, as has been asserted, the central problem of education is the control of learning, then a concept freighted with a control meaning is a preferred concept.

(c) Attention-Directing Devices and Methods

The problem of directing audience attention assumes importance when film research is considered in the larger context of the flow and processing of information. In a motion picture, sound film stripe, or a television presentation, the rate, amount, sequence, and nature of the information to be transmitted are fixed at the source. Production techniques are such that this information is presented smoothly and continuously. This can, and frequently does, present a problem of audience selection and discrimination within the entire range of information stored in the film, mechanically or electronically transmitted, and presented on the screen and over the sound system. Research findings in the intermediate zone of certainty, briefly discussed below, suggest that educational films are frequently overloaded with information. More information is transmitted than is received within the "channel capacity" of the audience. As the density of information increases, the amount of "received" or "accepted" information tends to increase, but the proportion tends to decrease.

Research findings on devices which direct attention to the relevant or critical information, such as "pop in" arrows, and on teaching methods which point out the relevant and/or critical information to be "searched out" in a film, indicate that such devices and such teaching methods produce an increment in learning.

C. *Zone of Intermediate Certainty*

This is an all-else and all-other zone that will be given short shrift because (a) the scope of the research that falls within it is so extensive, and (b) there are so many tacky problems involved in assigning research finds to this zone, rather than to the zone of high certainty.

Interestingly enough, variables and problems included in this area are important, both theoretically and practically. Rate of development, subjective camera angle, reading activities following film showings, the use of anxiety to increase learning from film showings, rate of verbalization, identification with models in films, films vs. film strips, "slickness" of production techniques, the nature of discussions following films and the number of participants, characteristics of teachers using and not using films, perceived usefulness of the information presented in a film, the open-ended technique and its effect in subsequent activities -- these and other problems lie in the intermediate zone of certainty in policies of knowledge. The hard-pressed Ph.D. candidate can find pay-dirt among the array of researchable topics included in this area.

IV. THE PROBLEM OF EXTRAPOLATION

In view of the number and excellence of available summaries of film research, it is quite pointless to go over the same ground in this symposium unless some new or different purpose is to be served. The discussion of the findings of film research in terms of the extremes of certainty can serve two purposes: (a) to guide the ambitious but unsophisticated researcher in educational media, and (b) to provide a basis for the extrapolation of educational film research findings to the medium (or, more properly, channel) of television in education. This summary is an attempt to establish some kind of a base from which extrapolation can be made.

However, extrapolation is not a simple operation. While there are areas of commonality between films and television, there are also areas in which differences may be critical and do not admit of extrapolation.

One of these areas of noticeable difference is between what is represented in educational films and what is represented in educational television. A dominant trend in educational television is toward the lecture -- illustrated or otherwise. This trend is a reflection of the manpower concept of the master teacher, whose talents may be shared over television among thousands of eager students rather than limited to the hundreds, dozens, or handful of students otherwise exposed to the manifestation of his scholarship. With the master teacher concept comes the romantic notion that, with television, the lecture can become "once again the well-organized, disciplined experience it was a couple of generations ago."

There is some question as to how this attribution of excellence to the lecture of past generations was made. It sounds very much like the refrain, "Things were better in the old days."

That part of Santayana's *The Middle Span* (23) in which he discussed his experiences at Berlin with Paulsen, Ebbinghaus, and Gezycki sheds light on this romanticism. After his first blush, and following an intervening trip to England, Santayana's enthusiasm was transformed into lasting disappointment. What he missed from these great professors, these great lecturers, if you will, was "more unity of spirit in teaching and in student life." "Were there no inspired philosophers then in Germany?", he asks.

Little film research has yet been done on the problem of the effectiveness of lectures recorded on film. Thus, if television is to be converted into an instrument for the revival of the lecture in the grand manner in education, very little can be extrapolated from films in education to television.

However, it may reasonably be assumed that the three high-certainty policies of knowledge of film effectiveness can be extrapolated to television, and that ETV research problems are to be found elsewhere -- in abundance.

V. FORMS AND CONCEPTS FOR FUTURE RESEARCH

The assigned task of this paper was two-fold: to indicate where we stand, i.e., what we "know" from film research, and to map out the areas that remain unexplored or inadequately investigated.

Identification of four areas in the zone of low certainty constitutes a partial topographic mapping of problems for future research. It is also possible, without stretching the point, to do some "topological mapping" by applying to the field of communications media in education some of the concepts, the research methodologies, and the theoretical formulations that have been developing over the past ten or fifteen years. When this has been done, we can briefly examine appropriate research approaches and necessary shifts in emphasis.

A. New Concepts

Obviously, it is no accident that this "where-do-we-stand" seminar is syncretistic in its structure and membership. A fusion of hitherto independent disciplines and points of view is essential if we are to cope with the range of problems involved in the introduction and use of newer media in education and if we are to bring to bear on these problems the useful concepts that have been made available to us. Four such concepts will be mentioned.

1. The System Concept

While we have long spoken of school systems, university systems, and educational systems, we have not taken the system concept sufficiently into account in research on films or other communications media in education.

The expanding field of automation involves conversion to more complex man-machine systems. This has introduced great turbulence in the labor movement -- a turbulence also noticeable among teachers and educational associations with the introduction of educational television, particularly the total television-teaching-by-closed-circuit pattern. This television-generated turbulence is also evident among exposed students from high school through college and among educational administrators buffeted by pressures from educational foundations, taxpayers' associations, student groups, school boards, teachers' associations, etc.

It is not within the scope of this paper to deal with the problems of educational television, except by inference and projection. However, with the introduction of any new educational medium and its accompanying technology, many problems become understandable and manageable within the system concept.

A system can be defined as an arrangement of components with a common purpose. The importance of the system concept is in the notion of (a) components in a system; (b) the integration of these components; and (c) the increase in system efficiency achievable by trading improvement of one component against improvement of another or others. The last of these involves the "trade-off" function. Trade-off is involved in the decision to increase educational efficiency of films either in the production stage or in the use stage. The basic mechanisms are the same. The components (teacher or film) are different.

It can be postulated that the more complicated the system technology becomes and the more often machines take over functions performed by man, the greater the probability of human resistance to the introduction of the technology becomes. Man does not surrender his historical prerogatives to machines without a battle, nor does he easily reconceive his historical role in the accustomed order of things.

Furthermore, as students of warfare have pointed out, the introduction of a new technology forces change in strategy and tactics. Applied to education, this means that the development of a new technology of communication forces change in the general and specific means by which educational objectives can be attained -- change that is frequently resisted as disturbing and discomforting to the status quo.

If we are to cope adequately in educational media research and in the implementation of research findings, use of the system concept is intellectually and practically inescapable.

2. Theory of Information and Communication

These have expanded at a phenomenal rate during the past decade and have generated concepts directly relevant to communication in education. While it is not clear that the mathematical theory of information is specifically applicable to semantic information, it is clear that the concept of information as "news," as having a quantifiable value in reducing uncertainty by reducing the range of alternatives, is a useful concept in education.

It is reasonably safe to infer that the development of communication theory is an outgrowth or concomitant of the development of information theory. Certainly, all of us are familiar with Shannon and Weaver's (27) discussion of communication theory, which is still valid. However, their discussion deals primarily with the structure of communication and only by implication with its dynamics. It does not go into the characteristics of information controllable by the source or the receiver, or both.

Rate, reliability, redundance, ambiguity, time-phasing, quantity, and discriminability of information are primarily source-controlled. Exposure, selectivity, capacity, receptivity, and durability of information are primarily receiver-controlled. Feedback is system-controlled. Matching the source-controlled and receiver-controlled operations is the art of communication. It is in this matching that the characteristics of the audience (the receiver) play such an important role. It is in the trade-off between production techniques and teaching techniques that difficult system decisions are encountered, since many of the characteristics of information, assigned above to source or receiver, are to some extent controllable at either pole of the communication transaction, and frequently involve or require attention and activity at both poles.

The least that can be expected from the use of information and communication theory in media research is an improved technical vocabulary that permits the researcher to deal with relevant variables. As previously indicated, an adequate technical vocabulary is not available elsewhere.

3. Theory of Bureaucracy

There is very little question that innovation is the central problem of newer media in education. Unfortunately, we know very little about the process of innovation. Bedford (3) has dealt with the problem of innovation by working through Rashevsky's (21) mathematical approach to history, i.e., to cultural change. In this scheme, innovation begins with an innovator who, by definition, has engaged in the creative act of restructuring both his image of the environment and his ideas of ways of managing and improving it. Innovation proceeds as a network of communication is developed, and the reconstruction is accepted by others. The problem of acceptance of innovation in education is definable in terms c. the bureaucratic structure of American educational institutions, i.e., in terms of change in bureaucratic behavior.

Three characteristics of the behavior of bureaucracies can be postulated. One, innovative *action* occurs on the operating level of the local bureaucracy, i.e., operational changes are made at the lowest action level of the bureaucratic hierarchy -- in the classroom. Two, tentative or initial acceptance and approval of the idea of innovation, and sanction of its mode of operation, are made at the top level of the bureaucratic hierarchy, where policy decisions are made and transmitted downward through the bureaucratic structure. Three, as the initial policies are implemented, the demand increases for local evidence that the innovation is situationally appropriate, situationally workable, and situationally satisfying.

Apropos of innovation in the educational bureaucracy, Kumata (13) observes that "Policy-makers do not accept conclusions in this (ETV) area based on research which has not been done on *their* students, *their* instructors, and *their* courses." Furthermore, he says that "I have come to the conclusion that one has to *fight* the battle of acceptance for use of television over and over again." For the most part, educational administrators and their operating personnel do not read the scholarly research journals, nor do they act on research findings, obtained in remote situations without localized proof, based on experience accumulated over a considerable time-span. "Classical" research in education is not directly translatable into action at the local level where active change always occurs.

4. Operations Research

Operations Research is important to newer media in education for its concept more than for its bag of research tools (linear programming, set theory, game theory, etc.).

The crux of operations or operational research is the central idea of applying scientific methods and technologies of research to real-life operating complexes for the purpose of obtaining data on the basis of which policy and operating decisions can be made with greater certainty of outcomes. One of the significant characteristics of operations research is that it is generally applied to specific problems in specific (local) situations.

In the academic community, operations research has little acceptance or status. Consequently, in research done in academic institutions or by academically-oriented researchers, the tendency is to shy away from operations research. This is unfortunate, since it is quite clear that educational innovation neither begins with nor is accepted on the basis of the type of research studies applauded at professional meetings and published in the high prestige research journals.

B. Interrelation of Research Approaches

Ordinarily, we tend to think of research as moving from the "laboratory" to the "field" situation, i.e., from basic to applied research. In practice, however, we can pursue the quest for understanding at any point on the continuum. Applied research, perceptively done, leads to "hunches" to be verified, modified, or denied in basic research, and basic research leads inevitably to the use of identified mechanisms in the planned programming of "real life" situations, particularly in applied sciences such as communication, and applied arts such as education.

The examination of emerging intellectual tools, such as those discussed immediately above, leads to a reconsideration of the more classic notion of where research emphasis is to be placed at any one time, and how we can best go about maximizing the effective use of newer media and devices in education.

If, as has been postulated, innovation in bureaucratically organized and controlled education is the central problem, it follows that operationally oriented research must be expanded by some exponential function. This conclusion, which I have elaborated elsewhere (9), casts considerable doubt on the adequacy of much of what has been called "contextual" research. Contextual research is research done in operating educational situations. A fine beginning has been made in this field, but by its contextual nature, it cannot deal with sufficiently purified variables to be "scientific," and, in practice, it has not dealt with the wide range of alternatives and the wide scope of decisions that must be made to maximize system performance in education in specific situations. "Contextual" research is a hybrid, employing the controlled experiment to control variables which can best be controlled in the laboratory, and ignoring many of the critical operating decisions involved in the art of teaching and the art of educational administration.

Many educational people share my uneasiness over some of the pronouncements and some of the tactics of foundations, particularly in educational television. It is increasingly clear that this uneasiness arises from what seems to be a fixed, pre-experimental decision to promote the use of television in education exclusively within a manpower concept of the educational process, rather than to concentrate on the identification of the systems problems encountered with introduction of this new technology of communication. Identification of these problems permits the use of variable patterns and local expedients in the reduction, if not the complete solution, of these problems.

Variable patterns and local expedients are inevitably developed in individual educational situations, with or without the benefit of research.

Since change in action patterns occurs on the operating level, and since change in action patterns is involved in the control and improvement of the educational process, it follows that research related to newer media of communication in education must move in an operationally oriented direction -- from an almost exclusive concern with the *what* to a greater concern with the *how*. We already know more "principles" and "laws" of learning than we have exploited with even a minimum degree of efficiency in formal education. The research job ahead is to find out how to apply existing knowledge as well as how to extend this knowledge.

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THE DEVELOPMENT AND ROLE OF TEACHING AIDS IN THE ARMED FORCES

By J. H. Kanner

Too little is known by civilians about the development and use of teaching aids by the armed forces. Dr. Kanner, who is assigned to the Office of the Chief Signal Officer, Department of the Army, and who has for some time held responsible positions in the armed forces teaching aid research and development program, here assesses the state of that program, and its implications for research.

The training of men is a major mission of the Armed Forces. Powerful pressures shape this mission. Among these are the complexity of modern weapons and limitations on available training time and on the number of high aptitude trainees and qualified instructors. These pressures have catalyzed the expenditure of time, wealth and effort in the research and development of methods and materials to facilitate military training. It is the aim of this paper to consider selected major aspects of these research efforts under the generic heading of "teaching aids."

Definitions and Orientation

Within the context of this paper, no distinction is made between the terms "teaching" and "training", and so the terms "training aid" and "teaching aid" are used interchangeably. This approach avoids the invidious comparisons often resulting from attempted distinctions between these terms and permits a more unified approach to the subject.[1] Having observed military instructors engaged in "training" personnel, and civilian faculty members engaged in "teaching" students, the writer feels the communalities in purpose, problems and self-perception outweigh purported value differences sometimes made when distinguishing between "teaching" and "training."

The objective of military training is to impart skills and information to trainees. To assist in the achievement of this objective, research has been supported covering a broad spectrum of factors believed important in the teaching and learning relationship. A consideration and discussion of some of the major factors will provide the framework of this paper.

The Instructor

Despite the use of motion pictures, television and mechanical devices and trainers, about 95% of military instruction is carried out by means of a live instructor. Yet the instructor represents one of the most critical and weakest links in the chain of military training. Unlike their civilian counterparts, most military training installations do not offer long-range teaching careers. For the military instructor a teaching assignment is often a two or three year interlude in his military career. If he possesses critical engineering or scientific skills, the competing demands of field or staff administration often outweigh or limit the need for his teaching these skills.

Turnover is very high among military instructors and new personnel often represent recent graduates from the course where teaching vacancies exist. When possible, such graduates are given one to two weeks of instruction in techniques thought to contribute to effective teaching. Following this, the novice is given teaching assignments and loads which would stagger his civilian counterpart. He finds one important aid, however, in his job. Most military instruction follows prepared lesson plans in which the various teaching and information objectives in the course are laid out for a prescribed period of time and in a prescribed order. These lesson plans attempt to insert logical progression into the teaching process, and may, for example, specify at what stages questions and answers may be invited or repetition and review inserted. At periodic intervals, senior instructors or educational personnel will visit instructors in the classroom to observe their teaching practices and make notes on their skills and deficiencies. These are later discussed, and, if needed, remedial action is taken.

There is general recognition within the Armed Forces of the severe problems posed by their instructional situation. This recognition has led to the support of research on ways of overcoming these deficiencies. There have been two major approaches. One is to leave the instructor in the classroom, but to provide him with aids -- motion pictures, television, charts or specified teaching methods -- which will improve his functioning. Another is to reduce or eliminate the need for an instructor by the more complete use of these aids, with the addition of such recent devices as automated textbooks or teaching machines. Let us proceed then to the first of a large number of training aids stemming from the need to improve military instructional efficiency.

Visual Displays

The most frequently encountered teaching aid in military training is the family of visual displays variously described as charts, cutaways, vuegraphs, slides, mockups, etc. Their major aim is to assist the instructor in demonstrating or explaining to the trainee such things as the workings of a complex mechanism; the actions of invisible phenomena such as electrical activity; or the logic or structure of a seemingly complex situation -- a tactical exercise, for example. Under visual displays are included devices which have the simple but necessary function of exaggerating the size of small equipment so that more trainees can see them. These include such examples as radio panels five by ten feet in size when the original equipment was perhaps 1 x 2 feet; or a ten foot wooden replica, with moving parts, of a three foot rifle. One function of these aids is to reduce the need for using actual equipment for teaching information such as nomenclature or the location of parts or controls. Where the original equipment is bulky and expensive, these aids can effect economies and expedite training.

Sometimes a simpler aid can equal or surpass a more expensive one in teaching effectiveness. As an example, Denenberg (11) compared an inexpensive mockup with a costly device -- the tank hull trainer and the actual tank equipment. He found the inexpensive mockup superior for teaching starting and stopping procedures and equal to the trainer and the actual tank equipment for teaching nomenclature and location of controls and instruments. It was in the teaching of the track and suspension system that the more expensive trainer was superior.

Perhaps the most important study in this area is that reported by Swanson and Aukes (40). In essence this study compared the teaching effectiveness of six types of visual aids in teaching aspects of the B-47 Fuel, Hydraulic, and Rudder Power control systems. Used in conjunction with a standardized lecture, the aids were animated panels, charts, cutaway trainers, nonoperating trainers, operating trainers and symbolic diagrams. The study failed to show any significant difference in teaching effectiveness among these aids. The least expensive one, symbolic diagrams, was as effective as the most expensive one, the operating trainer. Of equal interest was a parallel study (39) in which filmed versions of the lectures for the fuel and rudder systems of the B-47 using the operating and nonoperating models and charges were compared with live lectures and demonstrations. For immediate learning, the live lectures were superior to the films, although the differences were small. On retention tests these differences disappeared. At this stage the additional advantage of the film was demonstrated. The retention tests had shown little remembrance of the originally learned material. However, some groups were given a film review prior to the retention tests and profited so much by it that their scores were equal to those on the original test. This improvement was achieved by the use of a reel of film; to achieve the same effect with the operating trainer of the B-47 would have meant the air transport of 1000 lbs. of equipment.

In another comparison of visual aids, Murnin (33) compared a wiring board on which the trainee manipulated components, with a chart or diagram on which circuits were drawn by the trainee for learning basic electricity and the use of meters. It was found that neither of these devices taught basic principles effectively, that the aids were about equally useful in learning how to use meters, and that neither helped the trainee learn how to solve electrical problems. Finally, Torkelson (49) compared a mockup, cutaway and projected charts in teaching nomenclature of weapons. He found no differences in teaching effectiveness among these aids in immediate or retention test scores.

From the above it may be a reasonable inference that in the preparation of a visual aid for the presentation or demonstration of information, facts, etc., emphasis should be placed on the most simple and economical approach. The use of actual working parts, for example, does not seem to present any teaching advantage over simple schematics (40). For any type of teaching situation this emphasis upon low cost and simplicity in visual displays may be the most important usable contribution of military research.[2]

"Automated" Teaching Aids

The development of textbooks and machines which will partially or completely eliminate the instructor from the teaching situation represents a new and growing area of interest and effort. There are many reasons for this growth but perhaps two of them may be those mentioned by Gagne in another context: "Research on training devices is an area peculiarly fitted to the talents of the experimental psychologist, first, because he knows the field of learning, and second, because he usually likes to tinker with gadgets." (15)

There are a number of practical goals underlying the interest in and development of automated teaching aids. In view of the instructor problems described earlier, any procedure which would reduce or eliminate instructor requirements, without lessening teaching effectiveness, would be important. One recent study, which deals with the development of a special textbook or training guide, describes such a procedure. (53) Use of the book as an aid to the instructor marks the transitional aspect of this study. Certain guided missile operation techniques are taught on the job by experienced personnel. These personnel, however, are not trained instructors, and their method of teaching is often inadequate for the needs of the operator trainees.

To meet this problem a training guide was prepared which contained a detailed description of all operator procedures. For each procedure, the instructor and his students find in the guide primarily that information required to learn that procedure correctly. Following the teaching format of this training guide, this instructional procedure was employed:

"The instructor focuses his attention on one trainee at a time. The other student-operator follows the instruction, answers questions, and assists the instructor when necessary. Except for an initial familiarization with the NIKE system -- called the Orientation and Walk-Around -- all training takes place on the actual NIKE equipment. The instructor and his trainees follow six well-defined steps for each procedure:

"(1) The instructor first presents a general, over-all picture of the relationship of the procedure to the entire system.

"(2) He demonstrates by running through the procedure rapidly as he would on the job.

"(3) He repeats the run-through slowly, explaining each action taken.

"(4) The procedure is again repeated by the instructor, but this time the trainee does the talking, and he answers questions asked by the instructor.

"(5) The trainee takes over. He 'talks through' the procedure, informing the instructor of each action in advance.

"(6) The trainee practices the procedure as the instructor evaluates each run. Practice continues until two satisfactory practice runs are made." (21)

Comparative test results showed that groups receiving this type of instruction learned far more on both written and performance tests than those undergoing conventional instruction with and without the spur of periodic test instructions.

It will be noted that this technique was labeled transitional. The prepared textbook did not do away with the instructor, but prepared a program of instruction, as to both method and content, which the instructor would use as a guide in teaching. It was essentially a method for helping an inexperienced instructor do a better job than he would if left to his own resources.

Automated or programmed textbooks go further in that the goal generally is to eliminate or reduce the need for the instructor. A more specific goal of these programmed textbooks is to permit students of varying aptitude to proceed at correspondingly varying rates of progress. This goal reflects a serious problem in teaching groups of students of mixed aptitude or intelligence. In such a situation, instruction geared to low-aptitude personnel usually bores the bright students; and, conversely, instruction geared to brighter students leaves the lower-aptitude students confused and lost.

The goal of automated textbooks is not a new one. It has, in fact, been pursued by home correspondence schools for years. It is the approach which is different. In general, these textbooks are so written that students may proceed at a pace suitable to their aptitude. For example, a particular instructional objective may be covered by ten pages of text. A short quiz may then be inserted. If the student can answer the questions correctly, he proceeds to other instructional goals. If he cannot, he is directed by the text to read a certain number of other pages which further amplify the original instructional objective. Again the student is quizzed, and, if successful, may continue to new objectives.[3] If not, he is given further reading.

There is obviously a limit to this procedure, but the general assumption is that slower students can, by reading further, understand materials which their brighter colleagues grasp with less explanation. Another feature of this type of textbook is the frequent testing which provides the student with a continuous record of his comprehension and learning progress. The student is given a more active role in the learning process and has some control over his rate of progress.

A major question at this point is, what evidence exists on the effectiveness of these special texts as compared with conventional ones? Regrettably, data are both scarce and equivocal. Results reported at a recent symposium indicate some superiority for the special textbooks, but more time was spent on them by the students. (16)

The most recent stage in automated teaching devices is represented by "teaching machines." As pointed out in a recent article (31), these machines are not new. A prototype was developed by Pressey over thirty years ago. What is new is the recent surge of interest in these machines. Essentially, the latest machines add the factor of better control to the automated textbook. This control extends not only to the sequence of information given to the student but also to his response to test questions.

A machine developed by N. A. Crowder for the Air Force[4] appears representative of the most recent products in the field. (9) Material is presented visually over a rear projection screen about 8" by 12". To the right of this screen is a four bank row of buttons used by the student to make various selections. The viewing material may be static (e.g., printed, as in a book) or animated to show motion. Multiple choice questions are inserted to test comprehension of selected aspects of the instruction, and the student asked to select the correct answer. If the correct answer is selected, new information is covered; if not, the machine indicates the nature of the error and attempts to correct it.

Major impetus to the development and use of these machines may be attributed to B. F. Skinner which should surprise no one familiar with Skinner's philosophy and previous studies and views on the control of human behavior (40, 41, 42).[5]

This writer's estimate of the potential of automated teaching books and machines may be summarized as follows: (1) Their proponents have issued many promissory notes for value and effects,[6] but adequate evidence does not now exist to back up these claims; (2) The cost of these kinds of equipment is high, running in one instance to about $6,000 a machine, although increased production efficiency may reduce these costs. Cost is unimportant if something of importance can be accomplished with these machines and not by other less expensive methods. There is not enough evidence that this is now the case.

What is needed is a comparative study between teaching machines and other instructional methods, including film and television, using an adequate sampling of subject matter, and taking into account such factors as equipment and programming costs. The following question would be important: "If the amount of time spent in planning and programming for automated devices were spent on conventional teaching methods, what would be the result?"

One purported advantage of automated devices is that they permit students of different aptitudes to learn at rates suitable to their aptitude. This advantage has first to be demonstrated and then compared with a selection procedure in which, under conventional teaching conditions, groups would be formed on the basis of aptitude and given differential amounts and types of teaching. Another feature of these devices is that of constant testing and questioning, which, it is maintained, gives the student a continuing record of where he stands, and provides feedback knowledge of results. There are two reservations about this feature. The first arises from the question whether constant testing might not have deleterious effects upon motivation and learning. This appears to be a very rigorous, and possibly boring, way to learn. The evidence on the usefulness of feedback and knowledge of results on learning is favorable; the question here is whether their excessive use might lead to a decrease in motivation to learn. Secondly, there is the corollary question and observation that, after all, quizzes and tests are the stock in trade of the classroom teacher and have been used for a long time. Is there a learning advantage in being tested every five minutes or less rather than at the end of every hour? This should be part of the previously suggested evaluation of automated devices described above.

One may conclude that the area of automated teaching devices is one where scepticism should prevail until more evidence and experience have been accumulated.

Motion Pictures

The use of motion pictures as an aid to the instructor is widespread in the Armed Forces. A staggering amount of research was supported in the development of films for military teaching and communications purposes. Hundreds of new teaching films are produced each year by the Armed Forces, replacing or adding to, a large stockpile of such films. These films permeate military instruction at every level to an extent not duplicated in civilian teaching programs.

The extensive use of motion pictures in military training was fostered by the teaching demands of World War II. The need for training millions of men led to a great expansion of motion pictures, to teach hundreds of skills as well as to influence attitudes toward the enemy and the war effort in general. Within the Army, Hollywood actors, directors, producers and technicians were drafted and commissioned to produce films at the Army Pictorial Center in New York City -- a converted commercial studio -- and by contract other films were produced by Hollywood studios.

As far as can be determined, the construction of these teaching and attitudinal films was completely unaffected by any previous research findings. The common attitude was that men who could produce successful entertainment films, which cost and grossed millions of dollars, possessed the skills to produce military training films. Many of the clichés of training films construction were established during this period. "Motivation" was translated into introductions where the trainees were frightened, threatened, cajoled or bribed to learn certain facts, skills, or avoidance behavior.

The Disney approach was a popular one and little animated figures did Herculean labors in portraying anything from the abstractions of Ohm's Law to troublesome gremlins responsible for equipment breakdowns. This approach to teaching is still popular, as evidenced in recent televised films where cute and erudite forest animals are used to develop a "science" lecture. Prestige was thought to be an important factor in holding attention and improving learning, so many Hollywood stars appeared in new roles explaining with great seriousness the intricate workings of a Diesel engine, flight control procedures, radar operation and maintenance and many other technical subjects.

The writer has spent many hours looking at many of these now obsolete films. Despite the passage of time, and the supposed entertainment rather than educational background of their creators, many of the films seem comparable in format and approach to the most recent teaching film products. One implication of this statement may be that the research which has intervened since the making of these earlier films has had little influence upon the production of teaching films. The writer is convinced that this inference is generally correct; this point will come up later.

It was in the context of this hectic and busy wartime atmosphere, and under the conditions of film production described above, that the Research Branch of the Army's Information and Education Division found opportunity to conduct a number of film studies later gathered by Hovland, Lumsdaine and Sheffield in book form (20). The major emphasis of the studies was "on the measurement of changes in knowledge, opinion, or behavior produced by a film or other communication device." (20, p. 5). Among topics covered were attitude changes produced by orientation films, comparisons in teaching effectiveness of film strips and sound motion pictures, comparisons between "one-sided" vs. "two-sided" presentations in opinion formation, and the effects of participation upon learning. The studies were conducted during a war period. The major emphasis was upon using existing film materials not made for experimental purposes. Sometimes these existing materials could be edited or modified so that a particular factor could be studied under limited variation. Despite these limitations a standard of methodology was established that was rarely encountered in previous film research and not often exceeded in succeeding research.

The immediate postwar years saw a large-scale investment by the Armed Forces in film research. The Navy, in collaboration with the Army, supported a series of studies by the Pennsylvania State University beginning in 1947. As described by Greenhill in the final report on the program: ". . . The whole program was planned with a view to meeting a national emergency in which there would be an acute shortage of time, instructional facilities and instructors . . . During the eight years of its existence the Instructional Film Research Program undertook over eighty individual research projects. These have resulted in some 155 publications. . . By far the greatest number of studies were experimental in which a problem was formulated and relevant variables defined. These variables were usually built into especially prepared film versions. Critical comparisons of these film versions were then made using appropriate populations and measures of learning and attitudes." (17, pp. 1-2).

Most of these studies are bound together in two volumes (22, 23). In addition, a valuable product of the instructional film program was a report summarizing film studies conducted during the period 1918-1950, prepared by Hoban and van Ormer. (19)

A counterpart film research program was organized by the U.S. Air Force. About 1949, the Audio Visual Research Laboratory was organized with the general mission of research on the prediction, testing and experimental analysis of factors responsible for increasing the effectiveness of training films and related audio-visual media. It is impossible to summarize adequately the hundred or more studies emanating from both these programs, although some idea of the range of their interest may be given. An early study (3) was concerned with the characteristics of a classroom communicator. This device enables students or film viewers to answer questions or indicate their views during the seeing of a film by pressing one of five keys. The device would give immediate information about a film and (it was hoped) would "make possible new kinds of experimentation in the learning process." Lumsdaine & Sulzer (30) found that simple animation techniques for teaching instrument reading, such as pop-in labels and moving arrows, increased learning; Neu (34) found that the insertion of attention-getting sound or visual devices in a training film did not increase learning. Staudohar & Smith (44) studied the effects of various types of lectures supplementing a film on military discipline. They found that trainees who heard a lecture with the film expressed more favorable opinions on military discipline than those who saw the film by itself. There was no difference among the lectures in effectiveness. Kurtz (28) found that learning was improved when questions were inserted during the course of a film, but that an additional showing of the film was just as effective.

These are but a handful of the types of studies conducted under these two programs. Both programs have terminated. What is regrettable, however, is that, as far as the present writer knows, none of the results of the hundred-odd studies stemming from these programs are reflected in the teaching films produced by the Armed Forces today, and, to go further, this condition prevailed even when these research programs were in existence.

The failure of these extensive programs to influence the production techniques of films produced by the same agencies which supported their research efforts appears puzzling. Without pretense to a complete answer to this paradox, however, perhaps the following factors may point to the reason for this research isolation.

The first of these is related to the film making process in the Armed Forces. It differs little from that of commercial film makers in that a director and script writer and film editor are among the key people involved. It is the script writer and director who are critical in composing a film. These two would be in the best possible position to integrate useful research findings into the script and methods of presentation during the filming process. In addition, any footage is subject to the film editor's conception of what the final product should look like, and he would also be in a position to integrate useful research findings in his work.

Regrettably, the majority of script writers, directors or film editors are completely unaware of these film research efforts and their results. Under the joint Army-

Navy sponsored Pennsylvania State University studies, the researchers were academic personnel who rarely encountered the film production personnel or dealt with them on a continuous day to day basis. While the Air Force Program was mainly on an in-service basis, its personnel were not much closer to the film makers. It is the writer's contention that for the results of these research programs to begin being successfully applied to on-going film production, research personnel had to be an integral part of the same organization, near physically and available for consultation and influence with production personnel.

A second factor which should be given weight is that of the attitude generally expressed by production personnel toward research. Earlier it was stated that a prevalent attitude during the wartime production of training films was that anyone who could make a successful entertainment film could readily adapt to making a training film -- a kind of film often described as a minor subspecies where a homely mixture of "motivation" humor and animation could carry the "teaching message." This attitude, if not always explicitly stated in this extravagant form, still pervades and there is resentment when an outsider, especially one who is a "researcher", attempts to influence the film making process.

Finally, and this may be the most important factor, there appears the question as to what was usable among the results of the studies performed under these research programs.

The generality of the results of many of the studies is very restricted. Other results or suggested techniques are very time consuming. The testing technique described by Twyford (51) for example, would involve making the film, or part of it, for testing, and then reshooting it. Other techniques have involved using storyboards for pre-testing. Within the Army, where yearly production of hundreds of reels of film must be achieved, it would be impractical to use these techniques.

Such recommendations to the film maker as "The rate of development of a film should be slow enough to permit the learner to grasp the material as it is shown," (22) or "Ideas or concepts should be presented at a rate appropriate to the ability of the audience to comprehend them," (22) would seem difficult for the film maker to translate for his specific needs. On the other hand, such directives as "Special effects used as attention-getting devices have no positive influence on learning (22); or the finding that special effects as fades, wipes and dissolves do not appear to affect learning; or that music does not add to the instructional effectiveness of an informational film (22) could assist the film maker at least in avoiding expensive ineffectual techniques in his production.

The cardinal inference which may be drawn from the above is that for a film research program to be effective there must be very close liaison and relationship between research personnel and film production personnel. Or some method must be devised whereby the results of research can be put into effect. As an example, a film study was recently completed (29) which evaluated the use of a film as an aid in teaching military leadership. It was conceived that films could increase the realism of leadership problems. Ten films were constructed, under the guidance of the research personnel, depicting such problems. Students who received this special film training performed more effectively in solving leadership problems than those who received regular training. At the instigation of the military agency which had used the films, these ten films were adopted as standard training films and additional ones are being made using the same format.

At the present time, the Armed Forces are doing very little film research. One reason has been the appearance and rapid development of television. Another has been a change in approach in which specific problems of application, instead of problems of trainee learning, have been examined. For example, within the Army a special kind of film was developed, about five minutes in length, to reduce the delay of securing films and to meet many pressing training needs. This kind covers only a single teaching point such as one phase of loading a machine gun. Still another approach has been the use of film to teach longer and longer segments of instruction. In this application, instead of using a 15-minute film to supplement a 50-minute lecture, the course planner makes a series of 50-minute films replace an equal number of lectures or demonstrations. In other words, the administrative and cost saving advantages of motion pictures are being applied to a variety of military training situations.

It may very well be that a similar approach is warranted for civilian educational applications of film. Instead of expending their funds upon relatively small learning problems, researchers should try to explore the application of film teaching to more varied and extensive segments of teaching. Finally, the hope that the results of film research will find adoption by others may be realized only if there is close relationship between the researchers and those who might use their product.

Television

We are in the midst of an accelerated application of television in civilian and military teaching. The major problem today in teaching by television is how to get enough funds to purchase equipment. Large sums for research and equipment have been spent by the Fund for the Advancement of Education and U.S. Office of Education.

With this growth there have been periodic irate protests by college faculty and students against the use of television for teaching. The matter of faculty resistance is not one to be lightly overlooked and is one of the major problems facing the civilian adoption of television for teaching. But the present picture is one of increased use and optimism concerning television, unlike that period about seven to ten years ago when television was first being considered and tested for teaching purposes.

The Armed Forces were the first to experiment with television as a teaching aid. A major reason for this was the appeal of a device which showed promise for meeting many mass training requirements of the type prevalent in military training. In addition, the expense of television equipment limited early experimentation with it to the military services. A common approach, especially in the Army and Air Force, was to mount television equipment in a mobile van and demonstrate television to scattered installations.

Perhaps the first studies in the field were conducted by the Navy. The major question to be answered was how television compared with conventional instruction in teaching effectiveness. To answer this, the Navy studies conducted such comparisons and concluded that television was as effective as, if not more so than, conventional classroom techniques. (36, 37) Shortly afterwards the Human Resources Research Office, George Washington University, conducted for the Army a similar study (24) which came to the following conclusions: (1) Television instruction was at least as effective as regular instruction; (2) Television instruction was more effective for lower-aptitude groups; and (3) Television instruction was better remembered than conventional instruction by low-aptitude personnel. The Army television program continues to evaluate various applications of television for military training and has indicated such findings as the following: (1) Television was an effective means of reducing teaching time (25); (2) New instructors could be rapidly trained to teach over television (12, 25); (3) Television teaching could be presented for as long as eight hours a day for five days with little loss of teaching effectiveness (25).

Until recently, the most prevalent type of television study involved comparing television with existing instructional methods for teaching effectiveness (27). These studies are so numerous and new replications occur so frequently, that television researchers appear desperate in their urgings to avoid this type of study.

The heuristic value of this type of study should not be underestimated. The acquisition and use of television for teaching is often a traumatic experience. There is the threat perceived by the faculty or instructional staff of a major intrusion into their sphere of interest -- an intrusion which might translate itself into a massive replacement for their services. Despite the reports of others, there is a lack of experience and this lack is often overcome by making the first television effort a "study" of the value and comparative effectiveness of television with existing methods of teaching. The data are predictable and probably irrelevant to the major objective of gaining experience with the equipment, with the demands it makes upon personnel, and with its role in the school or university.

The Armed Forces were three to five years ahead of civilian workers in research and application of television to teaching. It was not until 1956 or 1957 that certain factors combined to spur equivalent civilian interest. Among these factors were the favorable results of television studies (24, 36, 37) and the efforts of the Fund for the Advancement of Education to support both research and procurement of equipment. It is the writer's belief that the Armed Forces, in particular the U.S. Army, are more advanced in their application of television to teaching than civilian institutions. If recent military work foreshadows things to come in civilian uses, a closer look at Army television may be of interest.

There are ten Army installations using television for teaching, with five more in various stages of procuring equipment. These installations use television to teach various subject matters in a number of ways. (50) A frequent use is as an adjunct to regular classroom instruction. In this use, television is viewed for the first fifteen minutes, for example, and is then turned off, and the classroom instructor takes over and continues to develop the lecture or demonstration. Television is used to demonstrate or convey information difficult to duplicate in the classroom -- a field exercise, perhaps, or a piece of bulky equipment in action, or, as a convenience to the instructor, a training film. The subsidiary use of television to transmit teaching films is growing. One reason may be that it relieves the instructor of the petty but tedious ordering, threading, rewinding and other details associated with conventional film projection.

The other major Army application of television is for the complete presentation of instruction over television with the instructor eliminated for those periods covered. Sometimes this complete use of television may cover one 50-minute presentation, preceded and followed by conventional classroom instruction. At other times, it may extend for several hours during the day or week for a particular course.[7] This application of television is generally combined with an effort to teach several classes at once so as to multiply savings in instructors and training aids.

Until recently, it was necessary to revise instructional schedules so that, for example, all classes receiving instruction in Ohm's Law would be scheduled for the same hour and day. This was not always easy to do. However, the advent of videotape has presented a major solution to the problem. Now repetitive programs are taped and shown at any time, thus fitting television to existing schedules and reducing or eliminating the need for revising schedules.

The advent of videotape has accelerated the trend to commit more and more military instruction to television presentation and to extend the number of courses in which television is being used at some stage to present instruction. The demands of live television instruction for meeting deadlines are a limiting factor on the use of equipment and personnel. However, with videotape, it is possible to rehearse and shoot an instructional presentation at almost any time. Once completed, the videotape can be played at any time or number of times or converted to film and shown by conventional projection methods. This technological change multiplies the resources of a television facility many fold.

The Army uses television to present lectures and demonstrations of many types. Field exercises are important in military training. They are expensive, and, when large in scope, are not always easily followed by inexperienced trainees. When televised to a particular viewing site, the need for transporting trainees is eliminated. More important, the television camera can focus upon critical aspects of the exercise or demonstration, thus insuring that the trainees will see them.

An early finding in Army television research was that a manual skill such as disassembling a light machine gun could be successfully taught by television (24). The finding has been translated into the teaching of wiring, soldering, assembly of electronic components, weapons assembly and disassembly and similar skills. From a teaching viewpoint, this use of television simulates a one-to-one relationship between instructor and student. Guidance can be given and errors pointed out; and, where large groups of trainees are involved, they can be taught far more economically than by an equivalent conventional approach.

Perhaps the most important application of television to military training is based on the use of the closeup. This use of television alone would justify its application in military training. With the increased use of complicated electronic, missile and other mechanical devices, the sheer inability to see the inner parts or workings of this equipment has become a pervasive military training problem. Many older or more conventional equipments such as tanks and radar vans pose similar viewing problems. In some ideal situations, two or three students may be able to view some part of a device in operation. But when the number of students runs into thirty, forty, or a hundred or more, the magnitude of the viewing problem may be appreciated.

Television, therefore, finds ready acceptance in overcoming many viewing problems. The minutest part of an action buried deep in a missile system can be seen by as many trainees as desired. It would be naive to do so, but a comparison of learning between trainees who benefit from this advantage of television and those who receive conventional training would upset the generally prevalent and complacent view that television teaches *as well* as conventional instruction. It would be no contest if tests were based on materials which generally cannot be seen or are difficult to view under conventional conditions of teaching. As a final example of this use of television, there is the televising of surgery and autopsies at Walter Reed Army Medical Center.

Another important Army use of television is to teach troubleshooting skills. These skills are the end goal of many critical Army training programs and are a very important problem-solving activity. Television is used in a number of ways to develop troubleshooting ability. A common one is to present to the trainees a straightforward description of how to diagnose and correct a malfunction. These presentations may be only five minutes long, but they are presented frequently throughout the course. By the time the trainee reaches the troubleshooting phase of the course, he has already been exposed to dozens of examples of effective troubleshooting behavior.

In a more recently developed application of television to troubleshooting, students are presented with problems and guide a studio repairman in the steps necessary to correct the malfunction on the actual equipment. In this method, students participate more actively in the troubleshooting activity. When they actually perform on the equipment, these television-trained students have had vicarious experience with a large number of malfunctions. They perform with greater speed, assurance and accuracy than students who do not receive this television orientation.

Stoddard (45) has proposed an application of television to civilian education wherein the bulk of instruction would be carried by television while the live teacher or "manager-teacher" would appear at certain critical periods to supplement the television instruction and attend to specific problems. An approach similar to this proposal has been developed in the Hagerstown project (45). However, Army television users are probably closer to achieving Stoddard's goal.

Military television research is now carried out largely by the U.S. Army. A current effort involves a comparison between color and monochrome television for teaching non-medical subject matter. Decisions on the future use of color television for military teaching will stem from the results of this study. The use of more costly color equipment could be justified by evidence of some superior or unique contribution to teaching effectiveness. In planning are two other studies. The first of these will be exploratory to determine the role of videotape in training new instructors. Preliminary experience on the apparent rapid insights into teaching behavior produced by the immediate playback afforded by videotape have led to the belief that tape can be used to train new instructors more rapidly in efficient teaching techniques -- particularly in speech and platform behavior. A second will study the increased use of television for teaching troubleshooting behavior.

Learning Theory in Military Training Research

Wolfle has stated: "The psychology of training is the applied psychology of learning." (52, p. 1267) The minor role that learning theory plays in military research reflects the truth of this statement. Although there is some evidence that this guilt is achieving extinction, experimental psychologists, particularly those engaged in military or industrial research, have periodic manifestations of guilt feelings over the lack of theory in both initiating and unifying their work -- these manifestations are often the prime instigator of symposia. (47)

The primitive status of what passes for learning theory today has not changed much since Spence's description. (43) Perhaps a representative description of the attitude of most applied psychologists is contained in Webb's statement: "I turn back to the laboratory and I find experiments done on rats, sophomores in college, or sixth-grade students in which they were in a soundproof room responding to a buzzer or a bell or a nonsense syllable. Then some three hours later they were tested on Rorschach, Card VI. Some specific conclusions may be drawn, but while sound generalizations result from these procedures, they are applicable only to the extent to which you can re-introduce the laboratory controls, which you never can. Therein lies the disastrous position of one who attempts to apply learning theory in actual situations . . . I can only be discouraging because in the three years I have spent at Pensacola occasionally attempting to apply learning theory, I have found no specific application of previous experiments other than indications of what variables to look for. I have never been able to apply specifically and directly any single experiment or any single finding presently existing in the realm of experimental psychology." (13, p. 59)

An awareness of the problem cited by Webb is contained in a 1953 paper by Hilgard (47, p. 3), in which he rejects the pessimistic view expressed by Newman, on the status of learning theory, that "a rabbit's foot is worth as much as the psychologists' sage advice." One of the troubles in theory development, according to Hilgard, is that "major theories are unnecessarily tied to outmoded schools of psychology." Each of these schools places "certain blinders" upon their proponents so that they neglect certain aspects. An example is the general neglect of motor learning by the Gestaltists. Hilgard concludes with: "I think it is time that we relegate the schools of psychology to their places in history and free ourselves as best we can from the narrowness that they have produced." (47, p. 4) The intervening years may have seen a fulfillment of this wish. As indicated by Kendler in his recent review of learning (26, p. 43): "It appeared to many, a decade ago, that certain theories, notably those of Hull and Tolman, were engaged in mortal combat in the arena of hard data. Now that the dust has settled, it seems that the combatants were more often shadow boxing. Damage to theoretical positions did occur, but in many instances the wounds were self-inflicted. However, these theoretical disputes nevertheless did serve a purpose. They provided much interesting data; but, more important, they revealed the stark inadequacies and limitations of existing learning theories. As a result the tenants of certain theoretical establishments were forced to pay more attention to the development of their own conceptual formulations than to the apparent defects of other theories. Today, most of the work in the psychology of learning is directed solely at developing theoretical formulations (or an atheoretical system) with apparent indifference to the problem of competing theories." The busy practitioner in military training research has not benefited noticeably from this development. An examination of recent studies will show that they share with their predecessors an almost complete absence of concern with learning theory or theoretical framework. Most of them are designed to meet very specific training problems and are an exercise mainly in design and analysis. Some idea of the pervasiveness of some of our hoariest psychological constructs in Armed Forces research may be inferred from the following titles: "The Relative Effectiveness of Massed Versus Spaced Film Presentation," (3); "A Comparison of the Whole and Part Methods of Marksmanship Training;" (32); "The Effects of Knowledge of Test Results on Learning of Meaningful

Material;" (18); and "Transfer of Training in Motor Learning as a Function of Degree of First Task Learning and Inter-Task Similarity." (14)

Hilgard's fourteen points (47, pp. 9-11) probably represent one of the most adequate and fruitful collections of guidelines to learning and research in learning available to the military researcher. The present writer is not so wrought up over this state of affairs as he was eight to ten years ago. Working on an empirical basis, psychologists have made and are continuing to make important contributions in military training and in related research fields. One may regret that our science is such a primitive one and yet take satisfaction in many of the accomplishments achieved under these conditions.

Summary

This paper has surveyed Armed Forces research in training aids and has indicated that shortages of instructors, limitations on training time and the increased complexity of weapons have mainly instigated this research. In the area of visual display aids, the general indication from research is that the simplest aids are at least as effective as the more elaborate ones. "Automated" teaching aids represent a new area of growing interest with the initial research and development for some of the recent devices underwritten by the Armed Forces. The future role of these automated aids must await the accumulation of evidence and experience. Motion pictures are an important aid in Armed Forces instruction and a large amount of film research has been supported by military funds. The results of this research, however, do not appear to be reflected in military training films, and possible reasons for this are offered. Television, as a military training aid, is undergoing rapid growth and has received considerable research support. A number of the advantages and applications of television are described. Finally, there is a brief discussion of the role of learning theory in Armed Forces research. The fragmentary and generally primitive condition of learning theory is reflected in applied military research. The present tendency of representative "schools" of learning to disappear and be replaced by development of individual theories is described as further accentuating lack of theory in military research.

FOOTNOTES

1. See, for example, McGehee's attempts at definition in (13).

2. An important factor in evaluating these aids is the quality of the lecture accompanying them. While this has sometimes been controlled in evaluative studies, it certainly cannot be in everyday instruction. Additionally, even if a specific aid proved superior to others under controlled lecture conditions, the variance in lecture quality encountered in everyday instruction would probably eliminate this superiority. These considerations underscore the recommendation that, for everyday instructional use, these aids be kept as simple and inexpensive as possible.

3. In Crowder's (4, 8) "scrambled" book approach, ". . . the page numbers are not presented in the normal sequential order, i.e., 1 through 10. Page numbers are interspersed at random. In order to 'read' the book the student must find page numbers through multiple choice statements. Each answer indicates a page number. The student turns to the page number which accompanies his multiple choice selection. If he has selected a wrong answer he is so informed, and is given an explanation as to why he is wrong. He is then directed back to the original statement page or to other pages pre-established by the program writer. He continues in this manner until he has completed the material contained in the book."

4. Now marketed as the Western Design Tutor.

5. Crowder and Skinner differ " . . . in the role errors are allowed to play in progression thru a program. As a result of variations in student input, Crowder believes it impossible to design a program in which a student can always be led to give the correct response. Thus, where Skinner strives to eliminate errors, Crowder provides for the commission of errors through multiple-choice questions and designs the program to give the student the information needed to correct the misunderstanding reflected in his choice of an incorrect answer. (10, pp. 2-3)

6. Allowing for the usual exaggeration of advertising material, here are some claims made for a particular device: "(a) shortens training time; (b) frees instructors from classroom 'routine'; (c) eliminates the need for constant supervision; (d) fully controls the training process; (e) provides a 'yardstick' to measure student progress . . . catches and corrects each error as it happens; (f) assures high quality of the end product."

7. At Lowry Air Force Base, four lecture hours of a course were taught five days a week for six months by television, and an increase was reported in teaching effectiveness as compared with classroom instruction.

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THE DEVELOPMENT OF TEACHING MACHINES AND PROGRAMMED SELF-INSTRUCTION

By A. A. Lumsdaine

Dr. Lumsdaine is at present a Program Director at the American Institute for Research, in Pittsburgh. He is co-author, with Hovland and Sheffield, of the well-known Experiments on Mass Communication, and was head of one of the large Air Force research laboratories, specializing in the study of teaching aids. Here he takes stock of where we stand in the development of teaching machines, and suggests tactics by which we can move faster.

The recent upsurge of interest in teaching machines and related techniques is often described as an application of the concept of automation to the learning process. When we speak of automation we are usually thinking about the simulation of intelligent human control functions by electronic, electrical or mechanical devices -- that is, broadly speaking, by machines. But since we do not ordinarily regard machines as inherently intelligent, automating a process does not really mean removing it from intelligent human control. Rather, it means that the form of control is transformed or encoded so that it can be displaced in time and space, can be indefinitely reduplicated in a standardizable way, and can often be applied at an accelerated tempo which may transcend the limits of human reaction capabilities. These are the kinds of things that are accomplished, for example, in the electronic digital computer -- and, thus, astounding as are the logical and computational capabilities of a modern computer, it is a misnomer to call it a "brain". The only intelligence it can display is that which has been programmed into it by man.

What are the possible applications of automation, in the sense just characterized, to the process of instruction? It seems clear that automated instructional methods would include any means whatever by which the functions of a teacher in guiding or mediating the process of a student's learning are encoded so they can be removed or extended in time and space and reduplicated as desired. This is what happens when a lecture demonstration is recorded electronically or photographically in the form of so-called audio-visual presentations. Thus, all of the so-called newer media -- films, TV, language tapes, and the like -- can be considered as forms of educational automation.

During the past two years Finn (1957 a, b) has provided a provocative discussion of the background and current status of these instructional media as viewed in terms of the automation concept, and Ramo (1957) has advanced some revolutionary ideas for greatly extending the concept of the automated classroom through application of complex electronic devices. The primary emphasis of both writers, particularly Finn, is on the automating of classroom instruction. Some of the concepts and possibilities they explore are closely akin to those reflected in the kinds of devices we currently call teaching machines. However, the writer believes the latter can most usefully be examined as a separate case.

If we look for the essential difference between the form of automation currently being sought in teaching machines and that obtained by the usual forms of audio-visual media which have been discussed thus far in this symposium, we will find that the most fundamental difference lies not in the physical configuration of the devices but rather in the kind of teaching function which it is sought to automate or simulate. Leaving aside the language laboratory as a special case, it seems clear that the kind of teaching that is automated by the televised lesson, and by most forms of instructional films, is essentially a form of classroom instruction by the lecture-demonstration method. This is typically a one-way, sequenced, paced presentation of information, phenomena and concepts to a group of students.

The students' responses to any such class presentation, automated or live, are largely implicit and non-overt, except for relatively infrequent introduction of some form of class-participation exercise. The presentation rate is determined by the instructor or, at best, by his estimate of the needs of the average student. Is Johnny learning what is presented? Should he be given more explanation? Is he really following, or is he daydreaming under the guise of a well-practiced attentive posture? Typically there is no way to know -- until too late, when the often dismal results of the bi-weekly quiz or quarterly finals are in.

The important point to note is not simply that these difficulties may be aggravated when we remove the teacher to the film or television studio. The important point is that they are to a greater or lesser extent inherent in all forms of group instruction in which one teacher tries to impart knowledge or skills to a sizable group of students by means of a lecture or quasi-lecture group presentation.

The kind of partially automated group instruction afforded by the filmed lecture or televised lesson may help offset instructor shortages, but it still retains the essentially one-way, passive-reception character of any lecture instruction since, as such, it makes no effective provision for frequent active student response and feedback. Thus, these media, although they may provide an equal or improved substitute for conventional class instruction by lecture methods, do not fundamentally change its basic character.

The inherent limitation thereby posed has long been recognized, and attempts have been made to do something about it. Primarily these attempts have centered around incorporating provision for active student response by recitation exercises or other forms of class participation interspersed between segments of instructional presentation. Such attempts have been the subject of a considerable amount of formal and informal experimentation, some of which has been summarized by Allen (1957), Lumsdaine (1959 a), and others. This experimentation has taught us a good deal about how some of the basic limitations of classroom teaching can be partly offset through class-participation exercises. However, important as these experiments are, they will not be discussed in detail here because, in dealing with teaching machines, we are looking for an alternative fundamentally different from the automated classroom presentation, not just for a way to bolster it up.

Is there an inherently better medium of teaching than classroom instruction? Many persons feel there is. Is it something new and untried? No, it is a method far older than any classroom, much less any film or television camera -- older, in fact, than recorded history. Call it tutorial, or Socratic, or coach and pupil -- what it boils down to is the direct, individually-paced interaction of a student with an individual tutor who teaches the student by guiding him through a program of questions, exercises and problems, constantly observing the overt responses of the student and adjusting the rate or difficulty of the program to the student's performance.

Recognizing the inherent merits of the tutorial method of individual teaching, why do we fail to use it in most of our educational endeavors? In all probability, for one main reason only: it's too expensive. If we can't afford one teacher for 30 students, how can we possibly afford one for every one or two students? A one-to-one teacher-student ratio is economic lunacy in ninety-nine educational situations out of a hundred.

But what if some of the essential characteristics of sustained individual teaching could be provided without any reduction in the number of students per teacher -- by implementing some of its basic characteristics, if not all of its specific features, through some form of automation? It is to something closely akin to this kind of possibility, in one form or another, that many of the proponents of experimentation with teaching machines are addressing themselves.

To put the matter in somewhat oversimplified terms, the essential difference between the teaching machine and instructional automation via the mass media of films and television lies simply in this: What the teaching-machine programmer is trying to automate is a tutorial process of individual student-teacher interaction, rather than a mass-communication process by which one teacher attempts simultaneously to pour out knowledge, as it were, into a multitude of receiving eyes and ears. This profound difference, rather than merely the fascination of some new kind of gadget, is what all the excitement over teaching machines is basically about, or should be about. The great idea behind the teaching machine, many proponents are convinced, is its potential capability for providing effective guidance and control of the individual student's behavior as he learns, much as this can be provided by a skilled tutor, and for doing so in a way that is economically feasible.

The programming of individual instruction

Many of the students of teaching-machine instruction feel that the most crucial aspect of automated self-instructional methods lies at least as much in the programming of the instructional sequences that they are to utilize as it does in the nature of the machines themselves. The devices are, in a sense, only the vehicles for presenting the instructional program to the student and allowing its presentation to interact with the student's responses. That is, their most important contribution is to effect a convenient and economically feasible method of inter-communication between program and student. However, the characteristics of the devices may also be extremely important because of the way in which they make the content of the program accessible and responsive to what the student does.

If a teaching-machine system is thought of as an automated individual tutor, the machine itself might perhaps be thought of as representing the tutor's eyes and ears, his vocal and other motor apparatus, and to some degree his discriminative and decision-making capacities. The content and organization of the subject matter he is teaching, however, are represented in the program that is put into the machine.

What would such a program be like, and how might it function? The very use of the term "program" is indicative. For one thing, this term properly suggests the idea of an orderly, though possibly quite complex, pre-ordered sequence, such as is present, for example, in a musical composition. The essential idea here is that careful control over the behavior of a learner as he masters each segment of a subject matter is afforded by very careful sequencing of material so that each succeeding step builds on what has gone before. A second connotation of the idea of programming extends this principle and suggests a partial analogy with the programmed instructions through which the processing of data is directed in a digital computer. The point of similarity is that a program that closely controls the behavior of the student so as to insure that he will develop a given repertoire of intellectual behavior, requires -- just as is true in programming a computer -- that we analyze in great detail the steps involved in the process. Since our subject is teaching machines and not digital computers, let us proceed, without pushing this analogy, to consider briefly what it means to analyze a subject matter into units that are programmable for presentation in a teaching machine.

If we examine the behavior of the human tutor in continuous interaction with a student, the first thing that is apparent is that the tutor concerns himself directly, at any moment, with only a tiny fraction of the total subject which he is teaching. Second, at each step he generally poses some exercise or problem or question for the student. Third, the tutor sequences these instructional elements in a particular kind of order. That is, he tries to start with what the student already knows, and then gradually leads the student through a sequence that will progressively and cumulatively build on to his prior repertoire in order to attain the intellectual capabilities or skills that the tutor is seeking to develop. Fourth, at each step the tutor makes a discriminative evaluation of the stage of progress at which the student has arrived, utilizing this knowledge to guide the sequencing of further exercises. He thus varies to a greater or less extent the program of problems with which the student is faced, so as to meet the needs of the individual student.

This last characteristic would seem to imply a program in which, because of wide individual differences among students, not only the rate but also the sequence of exercises would vary widely from student to student. This would in turn appear to require a highly contingent program, containing many points of branching or variation, to provide detours for clearing up points which a particular student may have failed to grasp. But, a further and crucial point to note is that, an experienced tutor is able to anticipate a great many of the difficulties which will beset his student, and on the basis of past experience he organizes his sequence of instruction to head off and prevent these potential difficulties. He thus carefully prepares the student at earlier stages for later problems which will be readily mastered if the proper groundwork has first been built. And in doing so, he may very greatly reduce the degree of contingency, or amount of branching required in his program.

A useful way to look at the question of how a teaching-machine program might develop real mastery of a subject in a student through a tutorial program is to ask how the behavior of a tutor could be simulated in pre-programmed form. In other words we may ask how the tutor might prepare an advance presentation for a tutoring session at which he could not be present, still retaining the essential characteristics of his method.

The inexperienced tutor could probably not do this. That an experienced tutor could do this with a marked degree of success by using suitable procedures is, in effect, the basic assumption that underlies one of the two major schools among those who are currently constructing programs for teaching by machines. This is the school of thought which holds that the need for a large number of alternative subroutines can and should be avoided by sufficiently careful working out of a program in which many of the possible occasions for remedial subroutines are foreseen, and most if not all of the remainder are eliminated in initial tryout stages of each program.

It should be made clear that there are currently a variety of approaches to programming of instructional material, some of which differ in minor details, others in major ways, from the sequence just outlined. The most fundamental difference, both in terms of educational assumptions and implications for the kind of teaching machine that is required, concerns the extent to which the programmer tries to achieve a "linear", or non-branching program -- that is, one in which, because the programmer contrives for the student nearly always to be right, there is little occasion for providing remedial or alternative sub-programs. We shall return to this question later.

It should also be noted that the concept of programmed instruction as a vehicle for assuring mastery of each step in a logical development of a subject is a more recent concept than the idea of a teaching machine. The earliest teaching machines developed by Professor Pressey were, in fact, originally conceived more for automating the quizzing or testing function than as automatic tutoring devices, even though from the outset it was clear that their immediate self-scoring features afforded important instructional values in addition to automatic testing capabilities.

Let us now turn to a consideration of some of the devices that have been developed by means of which such a tutoring program as has been characterized above might be presented to the student. In doing so, we should note particularly two provisions that characterize the student's interaction with the program. First, his active, overt response is continuously required at each step in the programmed sequence presented by his automated tutor. Second, he is immediately informed at each step, with minimal delay, as to the correctness of each response he has made. This information is contained in the program, but its timing and sequencing in relation to his responses are mediated by the machine.

A considerable number of teaching machines have been constructed which have these properties. They differ one from another in many respects, but these two crucial features are found in all of them.

A third characteristic that is inherent in the concept of all the teaching machines we shall consider is that the student proceeds on an individual basis at his own rate -- faster students progressing through an instructional sequence very rapidly, slower students being tutored as slowly as necessary, with an indefinite amount of patience to meet their special needs. Because of this individual pacing to fit each student's rate of progress, even the very slow learner can gradually be brought up to a satisfactory level of accomplishment, while the brighter student, after reaching a satisfactory level of attainment as fast as his abilities permit, can quickly proceed to more advanced material.

If one of these features has more primacy than the others, it is perhaps the active, overt student response to each step of the program. Why do we stress overt response by the student? There are two reasons. The first and less important reason is that, other things being equal, procedures insuring active, correct student response have been shown empirically to be more effective than those which do not. This has been demonstrated, for both individual and class instruction, by such experiments as those reported by Hovland, Lumsdaine and Sheffield (1949), Maccoby and Sheffield (1958), and May and Lumsdaine (1958). The second and more important reason is that only when responses are overt can they readily be observed, checked on and effectively controlled. The sufficiency of covert and implicit responses to mediate considerable learning is obvious, else no one would gain anything from reading a book without reading it aloud, or from watching a film without mimicking its actions overtly, or from listening to a lecture without chorusing back an echoing response aloud.

But while the effectiveness of implicit responses in learning can be considerable, the only way appropriate responses can be observed and their elicitation in the context of appropriate stimuli fully controlled or guaranteed is when they are made to become overt. This may be the main reason why good tutoring can be such an effective instructional procedure. The tutor can see to it that the right response gets made, can guide its elicitation until it appears and can provide both specific, unit-by-unit reinforcement for successes and immediate redirection of error tendencies. It is these functions which the teaching machine seeks to automate, partially or wholly.

Teaching machines for verbal learning

Let us see how some of these characteristics have been partially or more fully implemented in some of the teaching machines that have been developed. In doing so we shall at once see that automating a sequence of instructional exercises designed to build up progressive mastery of a subject by incorporating the three features mentioned above does not necessarily require complex equipment. Though some of the present forms of teaching machines are quite complex and some future ones may be more so, the basic elements of an automated presentation with the characteristics just noted can be realized with quite simple devices. Two such devices are illustrated in Figure 1.

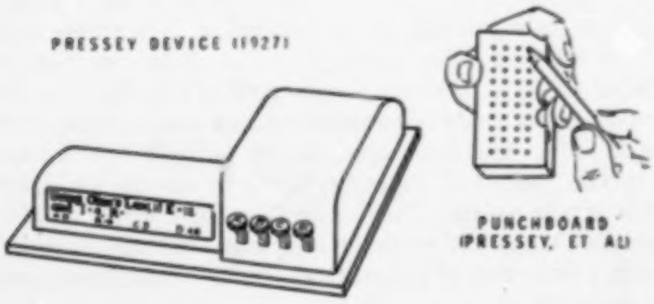


Figure 1. Early Pressey devices.

The device at the left of Figure 1 might be thought of as an ancestor of all subsequent teaching machines. It was devised by Professor S. L. Pressey (1926) over thirty years ago. Originally, it was conceived primarily as an automatic testing device, but it was apparent that its instructional properties were also of great interest. In the sketch at the left of Figure 1 is seen a window, at the left, in which a multiple-choice question appears. For example, in a course in elementary physics or electricity, the question might ask the student to identify the proper symbol to represent electric current or to solve a simple problem applying Ohm's law. His basis for doing so might be the prior study of his textbook, a film or lecture, or some other source. In a fully programmed self-instructional course the basis might consist almost entirely of what he had learned from answering preceding questions in the series.

In any case, suppose he chooses the proper answer, and presses the third push button, corresponding to this answer. If he does so, the machine signifies the correctness of his answer by presenting the next question or problem. But should he be wrong the question would stay in the window, an error would be tallied on a counter at the back of the device, and he would have to try again until he selected the right answer before the next question would be presented.

Some of Pressey's early devices also incorporated a mechanism by which items answered correctly on the first try were dropped out of the series so that on subsequent times through a set only those that had been missed reappeared (Pressey, 1927). This feature, incorporated also in some more recent teaching machines, means that effort can be concentrated where it is most needed and the student is spared the boredom and inefficiency of repeating material he has already mastered.

Some of the other devices developed by Pressey and his students were further simplified so that the four-choice answer apparatus was used with an ordinary mimeographed test form. This introduces the disadvantage that there is less control over the sequencing of information presented to the student: though these devices were keyed so that the student had to answer the questions in prescribed order, he still could look ahead or back in the series of questions and thereby obtain uncontrolled or non-programmed clues to the answering of a given question.

In the simplest devices developed by Pressey and others, the mechanical gadgetry was simplified by the use of punchboards to replace the mechanical push-button arrangements. In the punchboard device represented at the right in Figure 1, the student simply punched his pencil point through one of four holes, in a small punchboard, corresponding to the answer he selected. (See Pressey, 1950.) If he was right, a key-card under the punchboard holes could let the pencil penetrate to perforate the answer sheet; if he was wrong, the pencil point would be stopped, indicating an error to the student -- who then tried another answer. Still a different device for self-scoring and immediate feedback was devised by H. J. and J. C. Peterson (1930) by use of chemically treated answer sheets and a special marking pencil. These identified the correct answer by turning color when the student marked it. All of these devices entail multiple-choice responding, based on a small arbitrary selection of alternatives, rather than freely constructed responses composed by the student.

A more complex teaching device requiring selective responding to a large number of alternatives is shown in Figure 2.

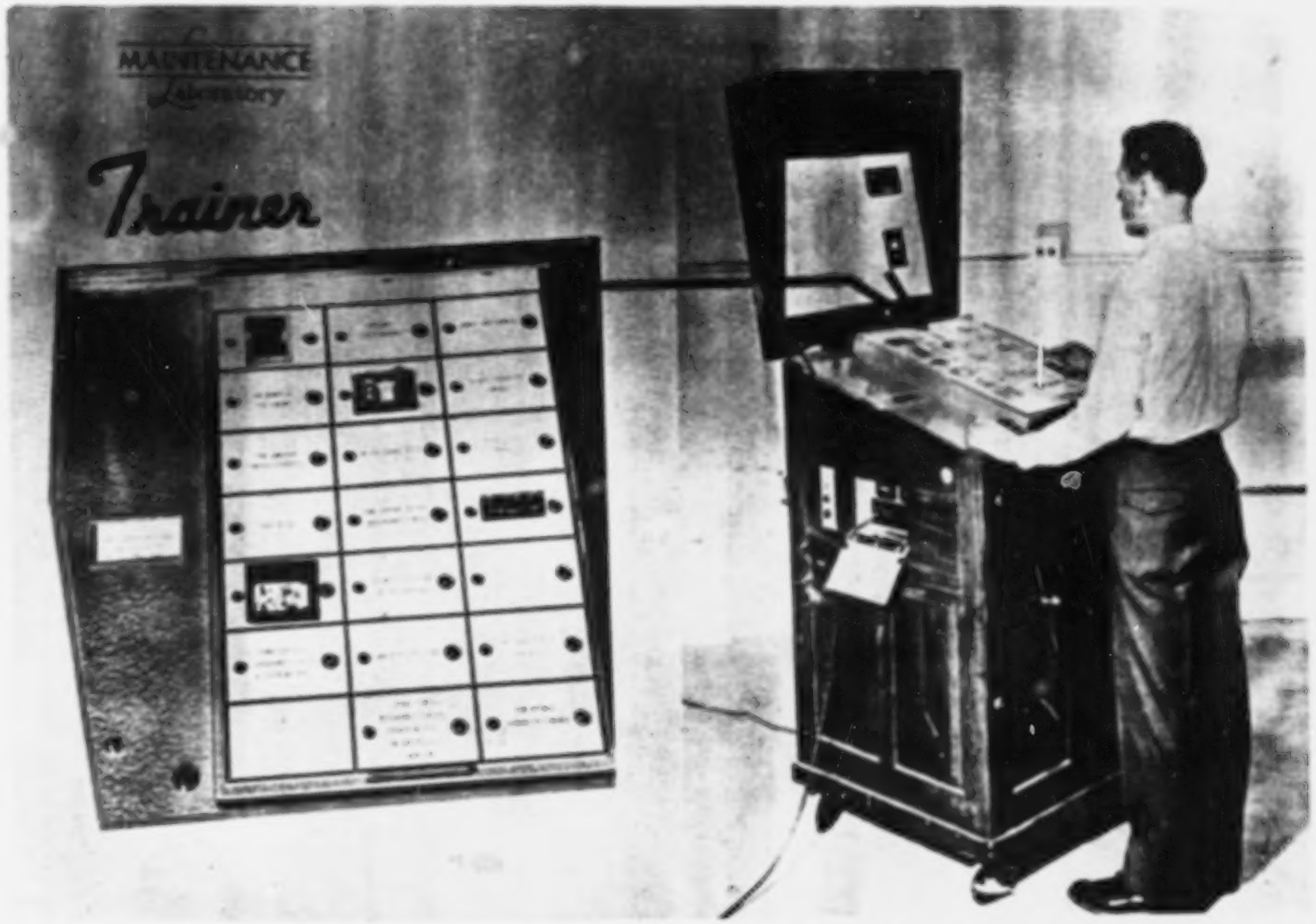

MAINTENANCE
Laboratory
Trainer

Figure 2. "Subject Matter Trainer." This is one of a class of automatic self-instructional devices or "teaching machines" particularly suitable for training in identifying of components, terms and other "one-to-one" associations. The student is continuously tested as he learns.

This device was designed by Besnard, Briggs et al (1957) as part of an Air Force research and development program, primarily to teach basic identifications required for job performance by Air Force technicians. This machine, called the "Subject Matter Trainer", presents, as did Pressey's earlier devices, a predetermined series of questions. These appear, one at a time, in the aperture at the left of the panel. The questions can be answered by selecting any of about twenty response choices, which are displayed either verbally or pictorially on the large panel. Beside each answer choice is a green indicator light and a push button by which the student may identify and record the answer he selects as the correct choice. The device has considerable flexibility, and can be programmed for use either as a testing machine or for any of several modes of operation for self-instruction in a variety of subject matters. For example, it can be programmed so that the green light indicating the correct answer choice comes on at once the first time through, so that the student is guided to the correct choice. Later, he may be required to decide on a choice; if he is correct, the light beside the answer he has chosen so informs him, while if he is incorrect the light next to the answer that is correct comes on. Still later, he may be required to keep trying until he gets the correct answer. All the while, his performance is recorded and his errors totaled, so that he is continuously tested while he is learning. As he progresses, the machine can drop out the items he has mastered so that the student's time and interest are not dissipated by unnecessary repetition. This particular device is obviously too costly for use on a wide scale in public schools. It was designed with considerable flexibility, and a number of modes of operation, to try out its uses in military training and also to serve as a research tool for investigating various features, data on which would affect the design of simpler future devices. Comparison with the Pressey devices suggests the interesting question of the merits and disadvantages of confronting the student with a larger or smaller number of possible answer choices.

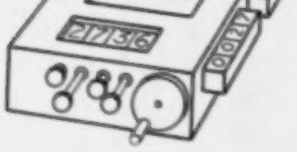


Figure 3. A self-scoring device that utilizes constructive responding.

The device shown in Figure 3 provides the student an even greater range of freedom in identifying his answer since the answer to a problem is "constructed" by setting in appropriate numbers or symbols in the answer dials. In this kind of machine, first described by Skinner (1954), this is done by operating sliders, and the answers are limited to numerical ones. In other devices, a similar arrangement, or a keyboard, may be arranged to extend the range of responses to include letters in which an answer of one or more words may be spelled out. Precisely the correct answer number by number or letter by letter is required before machines of this type will score the answer as correct and advance to the next problem. The particular device shown in Figure 3 is a special purpose machine, designed for teaching elementary arithmetic to grade school children. A problem appears in the large window on the face of the machine. The problem might be of any degree of difficulty from 2 x 2 up to a problem in long division or square root. The student, after whatever supplementary mental or scratch-paper figuring he needs, composes his answer by moving the four plungers at the front of the machine. These operate the dials to show his answer in the aperture below the problem. (In this case, 2,736, the correct answer, has been set in.) When he is satisfied with his answer the student turns the crank at the right. If the answer was correct, the machine advances to the next problem by moving a tape on which the problems are printed. If the answer was wrong, it scores an error and leaves the problem unchanged so that he must try again until he gets the correct answer before he can proceed. Or, if necessary, he can consult his instructor or a reference source. However, this may seldom be necessary if the programmer has proceeded by sufficiently small and well-organized steps, with a sufficient number of elementary examples before the more advanced ones, so that the student is nearly always correct.

Several similar devices have been built, some with an extended repertoire of response-construction including letters as well as numbers, to permit their use for teaching spelling and other verbal subjects. In these devices, as in Pressey's four-answer multiple-choice machine and Briggs' more elaborate twenty-answer multiple-choice apparatus, the correctness of the answer is scored automatically.

Most devices with more extensive response repertoires have sacrificed automaticity of scoring or of assessing the student's response, in order to keep the instrumentation from becoming too complex. In these devices, the student himself judges whether the answer he has given is correct, and instructs the machine accordingly. Perhaps the best known device of this type in use thus far is one shown in Figure 4.

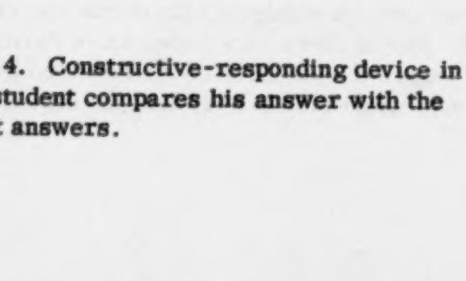


Figure 4. Constructive-responding device in which student compares his answer with the correct answers.

This machine (Skinner, 1958) employs questions that are printed on a disc mounted under the cover of the device and shown in the sketch by the dotted circle. Only one question at a time is visible to the student as it appears in the window marked "Q". The adjacent correct answer, just above at A, is not visible until the student has completed his answer. He does this by writing it on an exposed frame of a paper tape at the right, at R1. When he has written answer he is satisfied with, the student raises the lever at the left front of the machine. This simultaneously exposes the correct answer at A, and moves the answer the student has just written up under a transparent cover to R2, where he can see it but can no longer change it. The student now compares the correct answer with his own and decides whether he was right or wrong. If he decides he was correct, he moves the lever over to the right. This marks his answer tape to show that he scored himself correct on that question, and also operates a mechanism that reduces the number of times that question will appear again. (The number of correct answers required for each question may be either 2 or 1 with this machine, depending on the way it is set.) Whether the answer was right or wrong, the next question appears as soon as the lever is returned to the lower position, and the student goes on with the new question.

The device shown in Figure 4, the rationale underlying it, and the kinds of material for which it may be programmed in teaching mastery of principles and relationships are described in more detail by Skinner (1958). The basic respects in which the use of such a device to present suitably programmed materials can simulate many aspects of tutorial instruction are described by Skinner (1958) as follows:

"The machine itself, of course, does not teach. It simply brings the student into contact with the person who composed the material it presents. It is a labor-saving device because it can bring one programmer into contact with an indefinite number of students. This may suggest mass production, but the effect upon each student is surprisingly like that of a private tutor. The comparison holds in several respects. (i) There is a constant interchange between program and student. Unlike lectures, textbooks, and the usual audio-visual aids, the machine induces sustained activity. The student is always alert and busy. (ii) Like a good tutor, the machine insists that a given point be thoroughly understood, either frame by frame or set by set, before the student moves on. Lectures, textbooks, and their mechanized equivalents, on the other hand, proceed without making sure that the student understands and easily leave him behind. (iii) Like a good tutor the machine presents just that material for which the student is ready. It asks him to take only that step which he is at the moment best equipped and most likely to take. (iv) Like a skillful tutor the machine helps the student to come up with the right answer. It does this in part through the orderly construction of the program and in part with techniques of hinting, prompting, suggesting, and so on . . . (v) Lastly, of course, the machine, like the private tutor, reinforces the student for every correct response, using this immediate feedback not only to shape his behavior most efficiently but to maintain it in strength in a manner which the layman would describe as 'holding the student's interest.' "

Two simpler devices employing somewhat the same basic mode of operation are shown in Figure 5. One of these very inexpensive devices has been described by Porter (1959). With this device the program of instructional questions and answers is simply printed on sheets of paper which are fed into the device from the bottom. The question

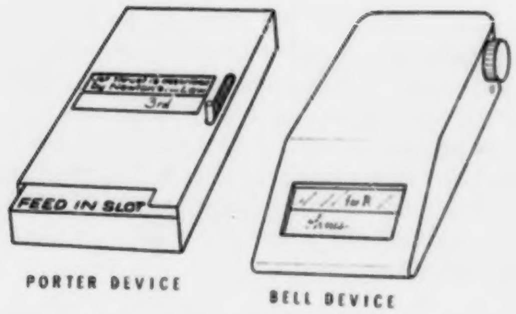


Figure 5. Simplified free-answer devices lacking item-dropout feature.

appears in the lower part of the window. The student answers the question right on the paper on which it appears; then he pushes the lever at the right. This exposes the correct answer, confirming his response if correct or providing a basis for correction if he was in error. A similar mode of responding to a series of items is provided by the other device in Figure 5, in which the items are printed on a roll of paper tape. Neither of these two devices has a provision for recycling a set of items with the ones correctly answered automatically dropped out of the series. The importance of such a dropout feature may depend partly on the way the material is programmed. Also, it would appear less important where any short subset of items can be repeated easily, as in the Porter device. For a program presented on a continuous roll of paper or strip of film, absence of the dropout feature may mean a larger program with a greater amount of sometimes unneeded repetition to assure mastery of all elements of the program. Research is needed to resolve the pros and cons of the dropout feature. However, it is clear that development is preceding research here, since devices without the dropout feature are already commercially available. The dropping out of mastered items is perhaps best considered as a special form of program "branching", which will be further discussed in a later section of this paper.

Even simpler variants of the fixed-program, free-response device which does not allow for repetition with dropout of a mastered item have been designed that still retain some of the key features of their more elaborate counterparts. One of the simplest is a so-called programmed textbook described by Homme and Glaser (1959 b) and by Glaser, Homme and Evans (1959). This employs response-and-correction sequences presented in a special, non-conventional form of "programmed" question-and-answer book, in which the answer to each question is always given on the following page. These devices are especially attractive in terms of cost, but they lack some of the features of stimulus control and fail to provide the fun of learning and being quizzed by a semiautomatic device.

The "Programming" of Verbal Subject Matter

The programs used in teaching machines of the kinds we have described are of great interest, and the techniques used in constructing these programs represent a crucial factor in the successful development of automated individual instruction. As we have noted, the programs that are currently being constructed for "continuous discourse" subjects tend to proceed by very small steps in which mastery of a subject is progressively developed as the student proceeds in the program. As he gradually extends his range of knowledge and understanding, he is afforded a basis for answering nearly all the questions correctly in terms of the information acquired in the course of answering preceding questions.

Perhaps the most important single factor in constructing such programs is the use of prompts or coaching cues, of varying degrees of subtlety and indirectness, which are used to keep the learner responding correctly and to keep up his motivation by insuring successful performance. The programming of such cues or prompts is arranged with initial maximum use to insure elicitation of the desired responses by the students, followed by so-called "fading" or "vanishing" of the prompts in later items of a sequence so that the learner is gradually freed from dependence on them.

In the instructional programs devised by Skinner and others for use in the kinds of devices thus far described, pains are taken to develop desired response patterns by using a wide variety of "contextual" and "semantic" prompts within a given item or "frame" of an instructional program. One simple example of the kinds of verbal prompts that can be used is partial presentation of a word, with omitted letters to be filled in -- the letters present varying from nearly all present (or maximal cueing) initially, to all or nearly all absent (or minimal cueing) terminally. Several examples of the many other useful techniques are presented in Table 1-A.

Another general method of providing prompts to foster correct responding in context is through dependence on stimuli provided in immediately preceding frames of the sequence. Table 1-B shows a brief three-item excerpt from a program in electrical fundamentals. The items would normally be seen only one at a time. Assume the student responds correctly to Item 62 with the word "transformer", on the basis of what he has learned in preceding sequences. If he does not, the correct answer will, of course, be provided after he has tried to answer the item. Cues for the response "coils" for Item 63 are provided by the statement just previously read in Item 62; similarly, the terms "primary" and "secondary" required in item 64, when the student gets to it, will have just been used in Item 63, and so on.

The techniques of providing prompting cues may be subtle or more obvious, and can be used for eliciting responses to pictorial or graphic stimuli as well as for verbal patterns. The following interesting example is cited by Skinner (1958):

"When a student describes the geography of part of the world or the anatomy of part of the body, or names of plants and animals from specimens or pictures, verbal responses are controlled by non-verbal stimuli. In setting up such behavior the student is first asked to report features of a fully labeled map, picture, or object, and the labels are then vanished. In teaching a map, for example, the machine asks the student to describe spatial relationships among cities, countries, rivers, and so on, as shown

Table 1: Some Contextual or Semantic Cueing Techniques

A. Some Prompting Techniques Used Within Frames of Teaching-Machine Programs

(1) Partial presentation of a word, with omitted letters to be filled in -- letters present varying from nearly all present (maximal cueing) initially, to all or nearly all absent (minimal cueing) terminally.

(2) Similarity of ideas, calling for a response that is provided in a similar context -- e.g.,

> Just as smoke rises, warm air will also _____.

(3) Similarity of grammatical construction -- e.g.,

> The higher the temperature, the faster the molecules move;
> the lower the temperature, the ____________ they move.

(4) Constriction of the range of response by grammatical construction, e.g.,

> The throttle is advanced just _____________ the ignition is turned on.

(requiring a temporal word such as before or after).

(5) Similarity of word roots with similar meaning used in a preceding "frame" or earlier part of the same frame -- e.g.,

> A candle flame is hot; it is a (n) __________________ source of light. (Desired response: "incandescent")

(6) Obvious transpositions

> Gross profit less overhead equals net profit; so to get net profit you subtract ______________ from ______________.

B. Prompting by Cues from Preceding Items in a Teaching-Machine Program

62. A ____?____, used to control voltages, consists of two coils of wire, wound on a core.

63. Input and output voltages of a transformer are governed by the number of turns of wire in the primary and secondary ____?____.

64. The ratio of the number of turns in the ____?____ and in the ____?____ coils determines the ratio of the input and output voltages.

on a fully labeled map. He is then asked to do the same with a map in which the names are incomplete, or possibly lacking. Eventually he is asked to report the same relationships with no map at all. If the material has been well programmed, he can do so correctly."

A number of other verbal prompting techniques have been described by Smith (1958), Skinner (1959), Beck (1959) and others.

The construction of programs

It is clear that a great deal of ingenuity and skill may be expended in constructing good programs. Currently, most attempts at programming of verbal subject matter proceed on a largely intuitive basis. If programming is to become a widely useful technology, the art of writing programs needs to be reduced to communicable guidelines that can help to structure the programmer's activity. To the extent that the rationale followed by many persons who are currently writing programs can be synthesized into an ordered set of steps, the procedure would appear to be somewhat as follows:

1st: The programmer tries to specify as exactly as possible the repertoire of behavior he wants the student to achieve through an instructional program. For example, this may be the ability to spell common English words, to solve quadratic equations, to compose English prose, to induce valid conclusions from experimental data, or to distinguish and identify animals according to a phylogenetic scheme. It is important to note that these desired outcomes are stated in terms of specific behavioral capabilities, not in terms of inanimate bodies of knowledge or vague mental functions.

2nd: The programmer tries to analyze the desired behavioral outcomes into the elementary components that appear necessary to achieve them, thus endeavoring to identify all of the perceptual and intellectual discriminations and other response capabilities which these require. He tries to include in this inventory all the necessary heuristic components as well as the elements required in the final performance. This will often be a very large job, but it is one which is likely to be an indispensable prerequisite for achieving instructional programs that can produce desired goals by a systematic, dependable process.

3rd: The programmer identifies logical and sequential interdependencies of these elements as a basis for arriving at a sequence of instruction on which each moment of instruction can build onto what has preceded it.

4th: He then devises ways in which each elementary unit of the heuristic or terminal behavior desired can be "spontaneously" elicited from the student in proper context and strengthened, a unit at a time. To do this he will make liberal initial use of prompting and coaching techniques such as those illustrated above, of continuous reinforcement for correct responses, and of one or more schemes for progressively diminishing the amount of prompting required as learning progresses.

5th: The programmer now writes a tentative program based on the foregoing, consisting of a progressive sequence of steps through which the student can readily proceed a step at a time with a minimum of incorrect responses.

6th: At this point the programmer tries out his trial program with typical students, using whatever detours are necessary to make up for any links in the chain that the student's behavior shows were inadvertently omitted. (In doing so the programmer in effect behaves as if he were himself an ideally flexible teaching machine.) He tries to record everything he does and the student does. The program probably doesn't work too well the first time, but the student's performance itself will often show the programmer how to modify it so it will work. By "work" the programmer means that the student's responses show that he has really mastered every step -- not just half grasped some notions about the subject.

7th: The programmer organizes the resulting program into units, containing as many optional or contingent sequences as are found empirically to be necessary to adapt to varied backgrounds and abilities of different students. Then he builds into either the teaching machine itself or the procedures for its use the capability of selecting or omitting these contingent sequences. (There may be many fewer such contingencies than one might have anticipated.)

8th: The format of the program is recast to fit the discrimination capacities of machines which the programmer has built or can build (perhaps with expert assistance), which will substitute for his own actions in presenting and controlling the instructional sequences.

When the programmer has done this it is likely that he will have achieved a very fair automated approximation of a tutorial capability by which the desired behavioral outcomes can be dependably achieved. He will have a program through which individual students can proceed, each at his own rate, building up gradual, cumulative mastery of the subject in a controlled, effective fashion. There is strong reason to believe that the use of such a program will be far more efficient of the teacher's time, far less frustrating for the student, and far more effective from the standpoint of achievement than conventional modes of instruction.

Even if this is true, the programmer will probably not quite have achieved a fully automated program adapted to all the idiosyncracies of individual students. It is too much to expect that any one program, no matter how carefully worked out, will eliminate all contingencies. It is for the crucial job of handling these contingencies that the teacher re-enters the picture to redirect the student, provide a remedial program, or work individually with students who need her special attention. This she will, probably for the first time in her life, actually have enough time to do, because many of the predictable sequences of coaching, recitation and drill which formerly usurped her time are being handled by automation in the form of a pre-prepared, machine-presented program.

Automated teaching of non-verbal skills

The devices and programs thus far described are intended for the teaching of verbal and symbolic skills. Other important objectives of training and education include the teaching of manual procedures and sensory-motor skills. Some kinds of procedures, such as the adjustment of a complex electronic device or performance of a quantitative analysis in chemistry, may be very lengthy, involving hundreds of steps. It is almost always possible to break down such lengthy procedures into a series of shorter sequences. "Knowing how" to perform a procedure of any length involves knowing how to perform a procedure of any length involves knowing how to perform each smallest step (which may resolve into a component identification of a single skilled motor act), linking these together into sets or sequences, and finally integrating these sets into the total procedure.

The learning of a sequence of steps, as distinct from knowing how to perform the individual steps of the sequences, can then be simplified greatly by programmed instruction consisting of easy to follow proceduralized instructions. Undoubtedly the most complete and readily followed way to present proceduralized instructions in automated fashion is through some form of step-by-step sound motion picture sequence.

In order to provide such an automated demonstration most effectively, we need individual daylight-viewing projectors, preferably designed so that they require no threading or film handling by the user. The projector should also be able to start and stop almost instantaneously at the beginning and end of each short demonstration segment. Such a projector, specialized as an individual teaching machine, need have only limited screen size and does not require the degree of fidelity and sound reproduction demanded of most classroom projectors.

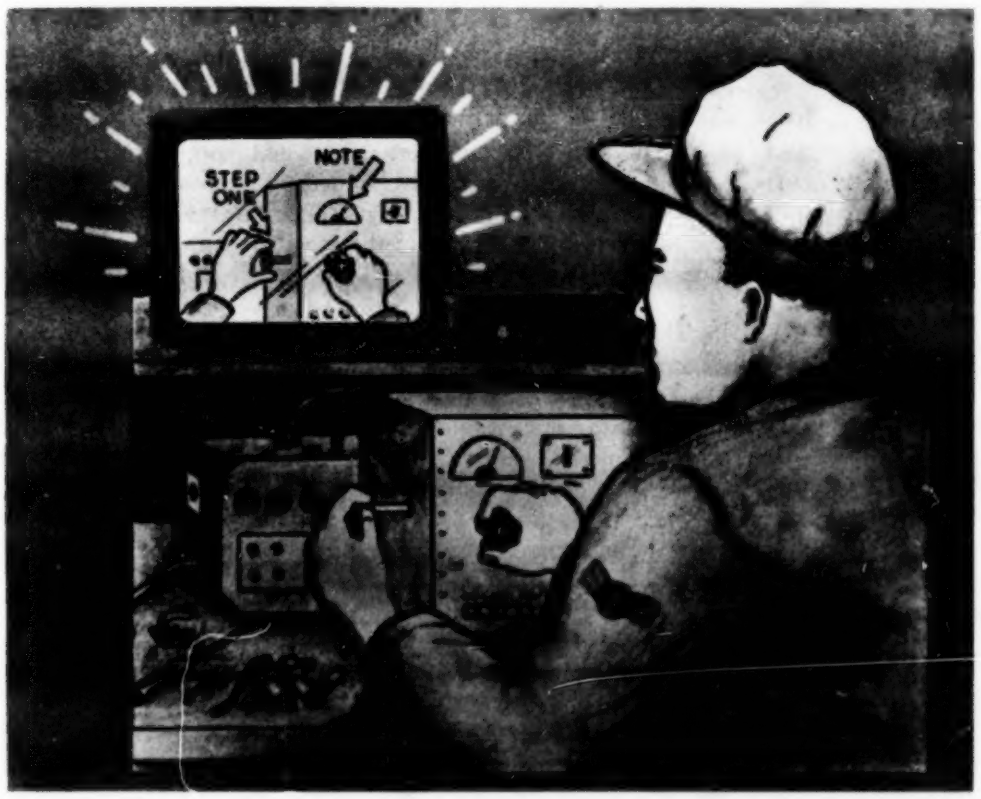


Figure 6. Use of special step-by-step film projection as a procedural training aid. A technician, watching a step-by-step procedure presented in short sequences, is able to copy lengthy and exacting procedures accurately with minimal training.

Figure 6 depicts the use of a start-and-stop projector as an automated demonstrator for teaching procedural skills in the laboratory or in apprentice training of technicians on the job. The demonstrational segments to be performed by the student can be tailored in length to his ability and prior experience, so that he can perform each step and check his work as he proceeds against a picture that remains on the screen until he is ready to go on with the next step. Thus, the trainee can learn while he works and may perform useful work while he learns.

More complex motor acts that must be rapidly paced and integrated into a smoothly flowing sequence are encountered in many phases of human activity, such as playing a musical instrument, participating in a sport, typewriting, or card punching. For some such skills, which cannot be readily acquired by imitating a visual demonstration, devices with special characteristics can be developed.

One of the most interesting devices thus far developed is shown in Figure 7. This device is called "Saki" by its inventor, Gordon Pask (1958), and has many interesting properties, some of which might be applied in future devices for other types of training. It represents one relatively simple but rather versatile application of flexible, student-governed training sequences achieved through the use of a small electronic computer, and is designed to teach the mundane but important skill of card punching.

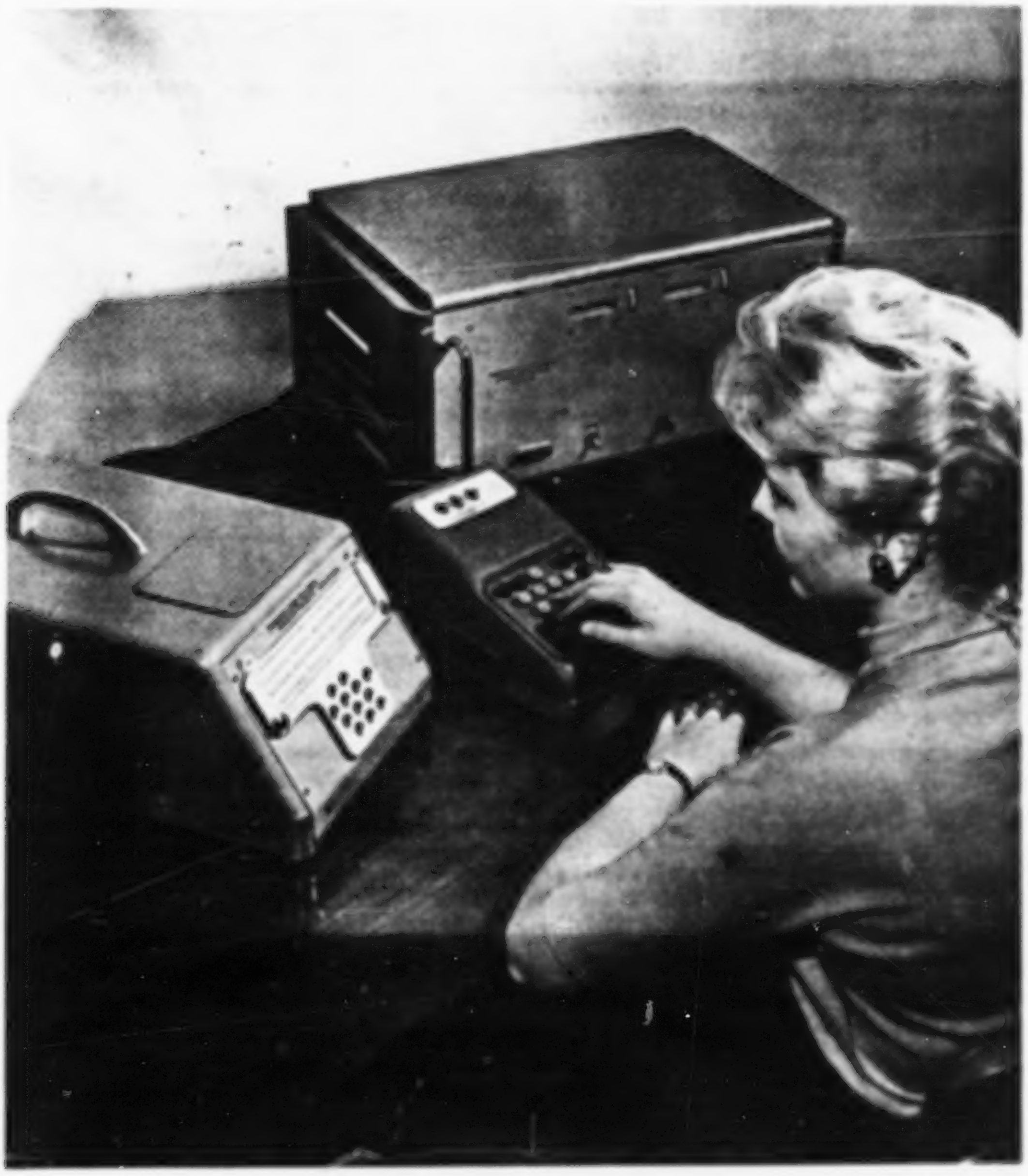
An important element of this and related keyboard skills such as typewriting consists, in a sense, of "memorizing" the keyboard in such complete fashion that sequences of numbers can be punched accurately and rapidly. In the Pask device, the trainee is presented with a sequence of numbers to be punched on the keys. The number to be punched at any given instant is indicated to him by illuminating it on the display. At early stages of training, cues to the location of the corresponding key are given by also illuminating the correct location on a pattern that provides a replica of the keyboard. The intensity of illumination is automatically reduced as the student gains proficiency -- a special form of the "vanishing" technique described earlier in relation to the progressive diminution of verbal prompts.

A further very interesting characteristic of the device is that its electronic feedback mechanism provides for varying the content of the practice materials that are shown to be in need of differing amounts of practice. This is done not just on the basis of a single response by the student, but rather by integrating his performance in terms of accuracy and speed over a period of time. A second notable characteristic is that the device "paces" the student, and is capable of adapting to and of influencing what amounts, in effect, to his "level of aspiration." It does this by adjusting the speed at which he must correctly punch the keys in order to satisfy his mechanical tutor and obtain the attendant reinforcement thereby provided.

The use of small steps in teaching procedural skills

A basic principle underlying the design both of automated procedural demonstrations and of teaching machines that employ fixed-sequence programs, rather than elaborately branching ones that are varied to correct a student's errors, is that of building up mastery through small, easy steps, so that the learner is kept performing correctly from the very outset of training. Techniques by which this can be done in the learning of principles and other verbal material have been illustrated above. Basically, they consist of giving the learner a great deal of help initially through prompting

Figure 7. "SAKI", an automated, self-instructional device for teaching specific motor skills. This device, developed by Solartron, Limited and now manufactured by Rheem in this country was designed by Gordon Pask for training punch-card operators.



cues, which are later gradually reduced or "vanished" to free the learner from needing to depend on them.

In the case of procedural training, often all that appears to be needed is a complete step-by-step demonstrational film and equipment to make its use easy and practical. The effectiveness of such techniques of training is fairly well attested by available evidence. Several investigators, including Maccoby and Sheffield (1958), have also concluded that attainment of efficiency in procedural tasks is optimized if there is provision for gradually reducing the amount of demonstration support afforded by the training device. One way to do this is gradually to increase, on successive practice trials, the length of the demonstration segments that are shown before the student starts to copy the procedures demonstrated. Maccoby and Sheffield found this produced superior learning either when the increase in the length of the demonstration segment was pre-programmed by the instructor, or -- at least for more proficient students -- when the students themselves were allowed to adjust the length of the demonstration segment they watched before attempting to copy the procedural steps shown. Automatic pre-programming can be achieved by various devices, such as the combination of film notching and sensing equipment in the prototype projector described above.

A promising application of the principle of gradual reduction in the amount of stimulus support provided by a procedural training device has been subjected to some preliminary exploration but has not yet been put to general use. This consists of a transition from a step-by-step sound-film demonstration for initial practice attempts to less complete procedural guides a bit later in training. One very good way to do this would simply be to turn the picture off and let the student perform the steps, following the oral directions on the sound track (or using a separate reproduction of these which could be played back with more compact and less expensive equipment at this stage of training). Still later, the student could proceed by partial or abbreviated oral instructions and then transition to a printed check list to which he could make quick reference without interrupting his performance of the task. Still later, if required because of the speed of performance needed, he could then readily continue to the final performance condition of following the procedure rapidly and efficiently on the basis of memory, using mental "cues" that are by now already well integrated with accurate performance of the procedure. Such a transition sequence would afford, for a great variety of complex procedural tasks, an almost fully automated means of procedural training that could result in highly accurate terminal performance as well as improved economy and efficiency of training.

Provision for variable sequencing (branching)

The devices discussed thus far present instructional sequences in a fixed order (except for the dropout of mastered items), for a considerable block of material determined by length of the sequence contained in a disc, on a reel of film or paper tape, or on a set of sheets inserted in the device. For some purposes, greater flexibility, allowing frequent "branching" in a sequence of problems or questions would seem desirable, so that the selection of the next problem or question presented to the student could be governed by his response to the preceding question or exercise. This is particularly likely to be desirable in teaching certain problem-solving or diagnostic skills, although Crowder (1959) and others advocate its use in other teaching as well. This adaptability, it is held, can adjust the sequence of instruction to the pattern of knowledge or understanding displayed by the individual student, thus more completely simulating the capabilities of a live tutor than one can with fixed or non-branching programs.

A device for automatic teaching which has a high degree of flexibility and can present a wide range of problem materials is shown in Figure 8. This device was developed originally on an experimental basis for teaching electronic troubleshooting to Air Force technicians. It provides for fully variable programming in which the sequence of instructional items stored in the device can be varied almost without limit. This device and several similar ones were developed in a former Air Force laboratory at Lowry Air Force Base. A similar device is now commercially available which will also present silent motion picture sequences as well as still microfilm frames. Such devices can select any sequence of questions, problems, or other material from several hundred items stored on microfilm. Each item is projected in an order that is determined by the response of the student to the preceding item or items. Questions may be posed in simple multiple-choice form with four or five answer choices, or a much larger range of possible answers may be provided. These can be presented in such a way that the student can indicate his selection in terms of a numerical code that identifies which of a large number of possible answers he regards as the appropriate one.

Problems presented may be designed to teach knowledge of principles and relationships or to afford practice in solving problems requiring the student to perform exercises that may require him to indicate which step he would take next, given the data or information thus far presented to him. Instead of merely being scored right or wrong, depending on whether he has chosen the best possible course of action, the machine can be programmed so that the frame presented to him next, if he makes an error, can explain to him the reason for his error before requiring him to make another attempt. Alternatively, it is possible to lead the student through a wide variety of remedial alternative sub-routines based on the nature of his errors, to show him (rather than merely telling him) the consequences of his choices, or to illustrate the application of various alternative strategies or principles in the solution of complicated problems. Devices for providing fully flexible access to such a library of sub-routines in filmed form that employ sound-motion pictures (see Ramo, 1957) have not yet been constructed. However, several existing and commercially available devices could be readily adapted for providing contingent aural (audio) instructions or stimulus materials for language instruction.

A highly simplified, though less flexible and less automatic variant of the device shown in Figure 8 has been developed by Crowder (1958) in the form of a so-called "scrambled book", in which the pages are in random order. With this "paper teaching machine" (unlike the Glaser-Homme "programmed text"), the page that the student is told to turn to next is contingent on the answer he gives to the problem or question presented on the current page. Illustrative programs for using such "intrinsically programmed" sequences in the form of a scrambled book have been worked out for several subject matters, including chemistry, fundamentals of electronics, and elementary number theory.

A microfilm device has the advantage over a "scrambled book" in that it is probably somewhat more interesting and motivating to operate, provides better control over the behavior of the student, and can readily be adapted so as to provide an automatic record of the student's response. With a more complex programming device, the sequencing of questions can also be made to depend not only on the answer to an

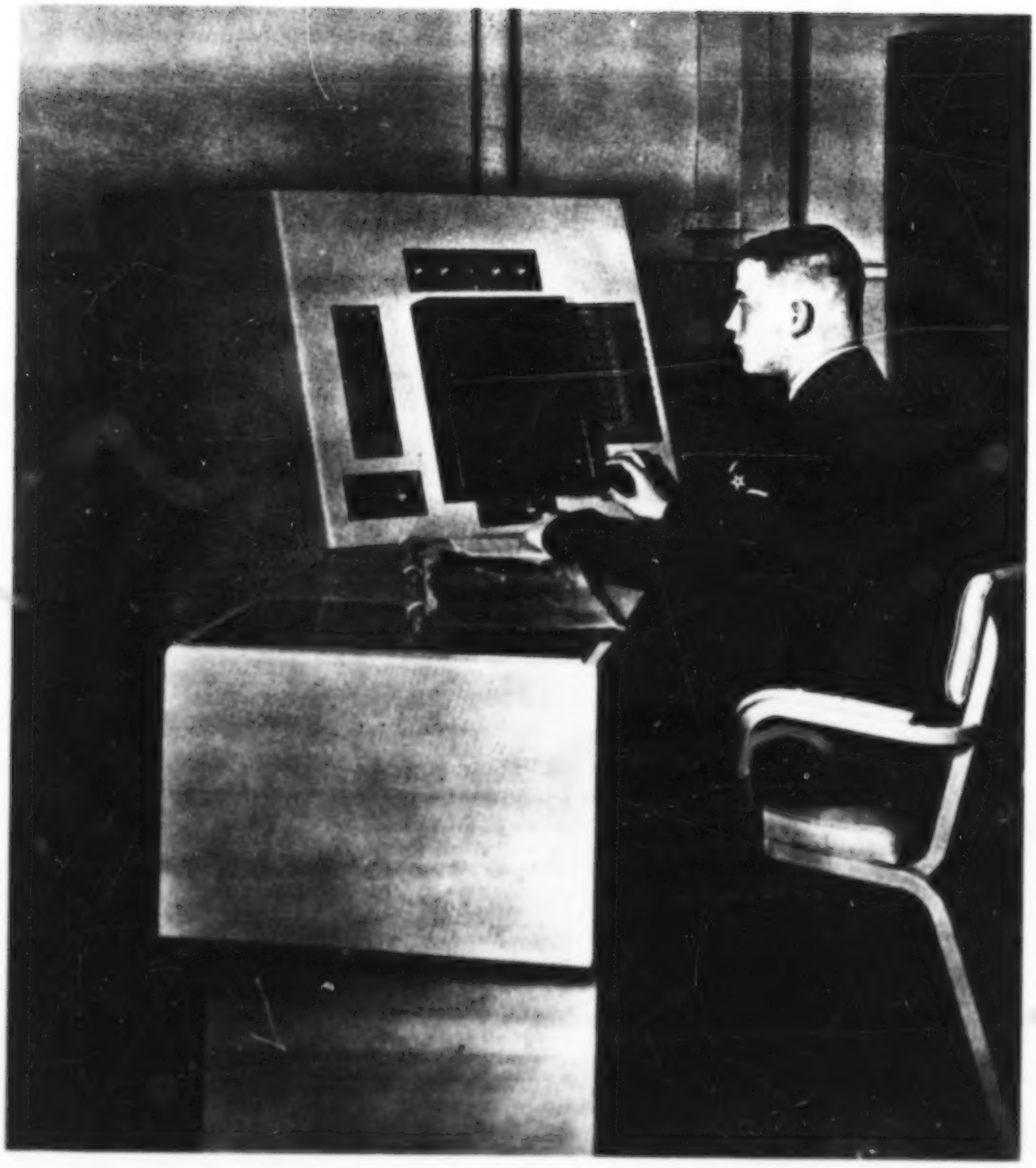


Figure 8. An experimental variable-sequence self-instructional device. The program of verbal or pictorial materials presented on the screen can be arranged in such a way that the presentation of new items of information depends upon the student's own performance. A similar device is now commercially available which will also permit interspersing short motion picture sequences.

immediately preceding question but also on a "pattern" of responses over a series of preceding questions. Some of the considerations in the design of microfilm projection devices suitable for widespread use are those of reconciling the requirements of (1) amount of storage capacity, (2) ease of loading the microfilm storage unit into the device, (3) average and maximum "access time" from any frame to another frame, and (4) cost of the device. Cost can be greatly reduced if one is willing to restrict the number of available alternatives after any question to a relatively small number, rather than requiring relatively rapid access to any item of the large number stored by the device.

There are, of course, many opportunities for program variation which do not require automatic item-by-item branching. In the Skinner and Briggs machines, for example, the program is fixed, except for dropout of mastered items, for some 30 frames or items. But at the end of any such set the student may, depending on his performance and needs, go on to the next disc, or go back to an earlier set of material to remedy some deficiencies in his prerequisite knowledge, or skip ahead to more advanced material. The question is, thus, how often need the capability for branching be provided in a program?

The utility of the Crowder form of branching as compared with other forms of programming is an important and complex question on which research is needed. Its potential advantages would seem to be most obvious in presenting problem-solving exercises which inherently comprise contingent branching sequences. The value of such highly flexible item-by-item branching seems much less clear in cases where concepts can be built up by easy steps, or where simple identifications or other paired-associate materials are being taught. The resolution of the problems of program branching will certainly be affected greatly by the success of programmers in anticipating and providing for certain contingencies in the manner described earlier in considering the pre-programming of a tutorial procedure. This is an example of the situation in which development may, up to a point, properly precede research, because the formulation of the problem for research depends on hypotheses concerning what it has been shown possible to develop.

We have thus far surveyed a reasonably good sample of the teaching machines that have been developed for attaining various kinds of behavioral outcomes through application of the three basic features that were identified as common to all devices that are currently being talked about as teaching machines. We have also discussed some of the central problems that arise in the preparation of programmed materials which in the end represent the sine qua non of successful automated teaching.

In doing so we have in passing identified a number of special characteristics possessed by some devices but not by others, and have implicitly or explicitly identified some of the issues for research that may be posed by the differences among devices that are designed to fulfill similar purposes. We may now attempt to summarize and interrelate some of the differences among devices and types of programs a bit more systematically, and to consider some more general issues concerning the use of teaching machines in an educational system.

The role of automated methods in an instructional system

The first of these broad issues that needs to be identified is a basic one which it is all too easy to overlook when one becomes enmeshed in the fascinating details of automatic devices and teaching machine programs: what role is to be played by automated teaching devices for presenting so-called programmed instruction, within the framework of a total plan of instruction? This broad issue includes not only the question of the categories of behavior desired as instructional outcomes, but also the relation of automated teaching programs to other forms of instruction.

Some of the specific aspects of these two questions are outlined in Table 2-A. They are, first, the type of learning outcomes sought -- a question of the desired "ends" -- and second, the role of the device in a total instructional plan in relation to other elements of teaching -- a question of the "means" to be employed.

In terms of the outcomes sought, we may be concerned primarily with the pervasive but seemingly simpler forms of specific verbal learning that are easily describable in terms of paired associates. Or we may, for example, have to deal with the acquisition of usable concepts and principles that are ordinarily tied to some form of connected discourse, where substance learning and interchangeability of symbolic responses are deemed essential. Again, we may concern ourselves with the learning of essentially sequential patterns, either verbal or non-verbal, as in memorizing a prose passage, poem, procedural list, or some series of motor acts to which we want a symbolic or perceptual sequence to transfer as a mediating instrumentality. Finally, we may be interested in teaching directly some criterion performance. This may be either a specific one involved in a motor act (like key punching or typewriting), or it may be a more generalized one which we would describe as the use of concepts and principles in such intellectual skills as malfunction diagnosis or other forms of problem solving. Careful analysis of exactly what kinds of outcomes are to be sought is, of course, important in any educational endeavor, but the need for careful distinctions becomes especially evident in teaching by machine-presented programs. Both the choice of device characteristics and the method of programming interact intimately with the kind of learning outcome sought. This applies not only in practical development of a specific program and in choice of a particular device, but also in the formulation of questions for research. For example, hypotheses concerning the pros and cons of a flexible branching capability might differ greatly for the teaching of procedures or identifications as compared with the teaching of the ability to use concepts and principles in problem solving.

The second of the two distinctions introduced in Table 2-A concerns the role of a teaching machine program in relation to other instruction. One bold and by no means necessarily impractical strategy is to place sole or primary dependence on a question-and-answer program presented by some form of machine or device to carry the main burden of instruction for a course, or at least for certain sub-units of a course. This has been attempted, for example, by Holland (1959) for psychology, by Gilbert and others for algebra, by Homme, Glaser and Evans for statistics, by Porter (1959) for spelling, by Meyer (1959) for elementary arithmetic, for at least three programs of teaching number theory and binary arithmetic (Crowder, 1959; Anderson, 1959; and Evans et al., 1959) and by Gordon Pask for teaching perceptual-motor skills involved in keyboard tasks.

A second kind of role is one in which the teaching machine program forms a follow-up, complement or adjunct to other instruction. The original multiple-choice programs of Pressey and his associates were of this type. It was not presumed that the teaching machine program would be used until after considerable prior study or

Table 2. Some Specific Sub-issues Related to the Role and Design of Teaching Devices

Major Issues	Specific Sub-issues and/or Variables	Example
Table 2-A: Role of Automated Teaching Devices (Issue No. One)	1. ("Ends") What are the desired outcomes of instruction to which the Automated Teaching Device is to contribute?	(1) identification learning (paired associates); procedural or sequential learning; "substance" learning--principles, etc.; problem solving and creative thinking.
	2. ("Means") What part is the Automated Teaching Device to play? (vis-à-vis other elements of the instruction?)	(2) sole vehicle of instruction; major complementary component; minor adjunct; etc.
Table 2-B: Device-linked Factors (Issue No. Two)	1. Form of student's response	(1) construction vs. recognition; "free" vs. constrained or discrete; large vs. small number of possible choices; etc.
	2. Basis for feedback/correction to the student	(2) automatic vs. judgmental scoring; correct answer necessarily revealed vs. not; correction at end of lesson, "frame", or constructed response element (e.g., each letter or digit); etc.
	3. Effect of student's response on the program	(3) item dropout; program branching, item-by-item or section-by-section; program variation based on single response or on performance over a series; program variation in content, speed, etc.; automatic vs. student-mediated branching
	4. Visual display characteristics	(4) controlled sequencing of large display (including pictorial) vs. spatially constrained; fixed vs. changing display within frames; special provisions for prompting cues; etc.

lecture instruction, and the quiz-like items and their sequencing were conceived as having follow-up review and testing functions. More recently, experimentation has been initiated with programs that are planned as a complement to basic lecture-demonstration teaching presented by film or television. Here their primary role might be conceived as that of automatically assigning, correcting and critiquing an extensive program of exercises to be done by students in a study period or as assigned homework. Finally, considerable attention has been given, capitalizing on what we may term the pinball philosophy of instruction, to making machines available for voluntary use by students in their free time. The optimal characteristics of devices and programs (and related research issues) may obviously differ depending on what role or roles a teaching machine program is expected to play.

Device characteristics

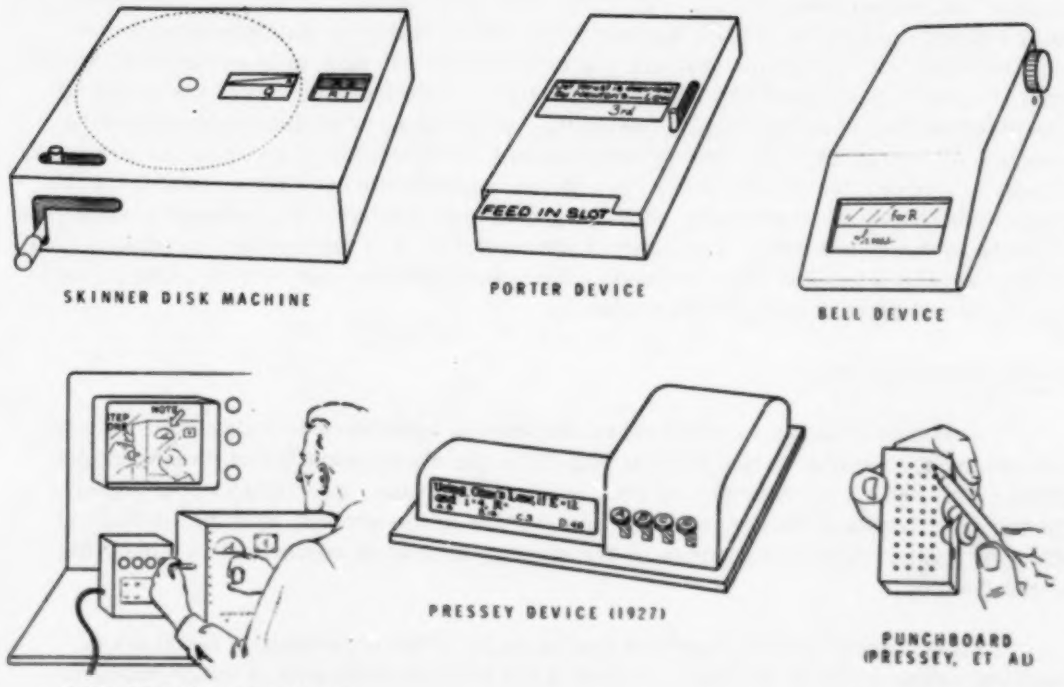
A second question to which many students of automated-learning methods are addressing themselves is that of what should be the characteristics of a teaching machine -- in terms, for example, of its response apparatus, its display capabilities, the forms of feedback or correction it can provide to the student, and the reciprocal effect of right or wrong responses by the student on what is registered or presented by the device.

As is implied above, answers are likely to differ depending on the class of learning outcome which is sought. Some of the kinds of questions to which research may need to be addressed are evident in comparing the characteristics of various existing devices. Four major characteristics with respect to which some of the devices we have described can be seen to differ are as follows: (1) form of student response; (2) basis for feedback or correction from device to student; (3) reciprocal feedback, to the device and its program, based on the student's response; and (4) visual display characteristics. Some of the specific sub-issues related to these four general kinds of characteristics are summarized in Table 2-B.

Now let us look at Figure 9, which shows a number of the teaching machines already depicted as well as some additional devices, and see how these differences are exemplified.

The devices at the top of Figure 9 all employ freely constructed responses made by the student. The devices at the top left (Skinner, Porter, etc.) are designed primarily for "continuous discourse" verbal subject matter. The student makes a written response; correction or confirmation of the response is made possible when the student then causes the device to display the correct answer. He compares this with his own written answer and scores himself right or wrong.

Judgmental scoring on the basis of comparison with a model is also employed in the kind of device illustrated in Figure 6 and at the upper right of Figure 9, although here the form of response and kind of learning required are quite different. A motion picture or slide presentation with accompanying recorded oral directions is used to teach sequential procedures. As in the verbal learning machines just above, the learner can proceed by very small steps, here consisting of short demonstration segments, which he can readily imitate, and can then check the step just taken against the pictorial model on the screen.



SKINNER DISK MACHINE

PORTER DEVICE

BELL DEVICE

STEP-BY-STEP SOUND-FILM DEMONSTRATOR

PRESSEY DEVICE (1927)

PUNCHBOARD (PRESSEY, ET AL)

VARIABLE-PROGRAM MICROFILM DEVICE (CROWDER)

SUBJECT MATTER TRAINER (BRIGGS)

"SAKI" (PASK)

DIGITAL COMPUTER (RATH-ANDERSON; PERLIS)

ARITHMETIC MACHINE (SKINNER-ZEAMAN)

"POLYMATH" (ROTHKOPF)

Figure 9. Teaching machines illustrating various characteristics; also showing component elements used as Figures 1-8.

The external manipulanda employed here are, of course, much more complex than those with the verbal machines, where only a pencil or pen is required. However, the essential pattern of feedback is basically similar, as it consists of comparing some form of freely constructed response judgmentally against a visual criterion. (Also, the mediating symbolic responses may involve similar implicit verbal processes even though the performance and learning outcomes are quite dissimilar.)

In contrast to the devices at the top, the devices near the center of Figure 9 (Pressey, Briggs, etc.) differ in several respects in the response form they employ and in the type of feedback they provide to the student. First, the apparatus is self-contained (not requiring even such minimal external apparatus as a pencil or a pen to make a response). The student simply pushes a button to indicate his answer. Second, the response repertoire is restricted to discrete choices instead of including free responses. This has at least two important implications. In the first place, the device can be said to involve selective rather than constructive responding. However, this distinction can easily become blurred if the number of choices is large (consisting of up to twenty choices as in Briggs' "Subject-Matter Trainer", or even more in other devices -- see below). The relevance of the distinction also seems less clear-cut where the criterion response desired is actually that of selecting or identifying, or where a "freely constructed" response can be coded or analyzed into a finite number of possibilities.

Furthermore, the use of discrete responses readily permits automatic scoring or right-wrong discrimination, instead of requiring judgmental comparison as the basis for scoring, correction or confirmation. Because of this, correction-feedback or scoring may be accomplished without directly revealing the correct answer. Thus the student's selection of a wrong response may (depending on how the device is constructed and programmed) score an error and require him to make one or more further attempts before he can proceed to the next question in the sequence.

At least one important feature is shared in common by the devices in the first two rows of Figure 9, or at least by all but the simplest of the latter (the punchboard, which is used with an accompanying sheet to present a series of questions). This is the fact that they provide stimulus control of the question elements in a program such that the student is prevented from looking backward and forward in the series while responding to a particular item. In most of these particular devices, it may also be noted that the length of the verbal stimulus displayed for each "question-frame" in a program sequence is spatially constrained, permitting only a short verbal question-statement. More extensive stimulus material (e. g., any sizable pictures or diagrams) must therefore be presented through adjunctive displays for which there is not necessarily the same degree of stimulus control as is available for the basic question presented in the machine's question-frame. (This disadvantage is avoided in devices using projected microfilm, such as the Crowder device.)

The devices depicted at the bottom of Figure 9 combine the features of "constructed" response with those of discrete and automatic wrong-answer discrimination (and the attendant characteristics of this feature as just identified). The simplest of these is the special-purpose arithmetic machine (Skinner-Zeaman) at the lower left, in which sliders and dials are used to "set in" an answer to a numerical problem.

An experimental device (Rothkopf's "Polymath", shown at the bottom of the figure) incorporates automatic answer-discrimination with an extended response repertoire which permits multiple-choice responding (which can be related directly to the special configuration of the primary display -- a large-area one, in this case) and also an alpha-numeric, constructive-answer input through sliders similar to those in the preceding device. In addition, through use of criterion patterns employing printed circuitry on the back of the display sheet (not visible to the student) free, two-dimensional positioning or tracing responses can be automatically entered into the discrimination-scoring apparatus and memory of the device (for example, such responses as tracing a route on a map or a signal through an electric circuit diagram displayed in a particular "frame" of the program). The utility of such extended response-registering apparatus for various kinds of instructional requirements is an interesting field for investigation.

The most complex of the devices that can automatically score a full alphabetic and numeric repertoire consist of electronic digital computers coupled to suitable keyboard input and printout devices. These have been or are being used to teach computer programming as well as other subjects -- e.g., binary arithmetic (Rath, Anderson and Brainerd, 1959).

This complex degree of instrumentation also permits the incorporation of at least two additional features with respect to flexible correction-confirmation and program sequencing. First, correction-confirmation can be provided for each serial element of a complex verbal or numeric response, letter by letter or digit by digit. Second, the great versatility of the computer frees the teaching machine from the constraints of simple predetermined sequences. It thus permits the very free use of contingent branching sequences -- in much the same way that many human tutors adapt their programs of questioning and discourse to the response of individual students and the needs which these responses indicate.

Alternatively, as we have seen, fairly complex branching sequences may be more simply mediated by semi-automatic means -- for example, in the kinds of programs devised by Crowder for use in the variable-program microfilm projector shown at right center in Figure 9. As we have seen, this can be done through what Crowder calls intrinsic programming. Note that in this arrangement the student's answer to the question is punched into the machine to indicate his selection of alternatives in answering a conventional multiple-choice question but that, alternatively, the program could instruct him to choose an answer in accordance with a numerical code assigned to a much larger range of possible choices -- e.g., checkpoints in a circuit, or locations on a map.

Some issues in the design of programmed materials

From the foregoing analysis of device characteristics, it seems quite clear that, even within any defined set of instructional objectives, a host of specific research questions is generated by such differences as those in the response repertoires, display characteristics and branching capabilities of various teaching machines -- and, also by the differences in programming philosophies to which these differences are partially linked. An outline of some of the major questions that arise in relation to the programming of instructional material is presented in Table 3. Some of the factors identified in Table 3 also have implications for design of devices, but as stated, they relate most directly to the writing of programs.

Table 3. Some Major Questions Concerning Programming of Material

Major Questions	Examples
1. "Size-of-step"	(1) Length of "frame" (number of words or sentences); difficulty of giving correct answer at that point in program; complexity or length of response; number of responses to questions before correction/feedback or reinforcement.
2. Content of prompts or manner of cueing	(2) Contextual (semantic or formal) within frame; cues from immediately preceding frames; cues from preceding "trial" or cycle; physical variation in clarity of special prompts.
3. Content of correction or answer-frame	(3) Right-wrong only, reveals correct answer; gives additional prompts if incorrect; explains why wrong, or gives other explanation; etc.
4. Logic of program sequencing	(4) Uniform vs. contingent sequences, interacting with type of material and with step-difficulty sought; principles to applications, or vice-versa, or mixed; spacing and form of review; method of integrating part-learning; etc.

Definitive experimental research to resolve these and other problems involved in program construction is not as easy to formulate as it might at first seem. All of the issues posed seem to require quite careful analysis, as well as very clear formulation that takes into account the interaction of related factors, before all of the issues posed can most profitably be attacked by systematic research. For example, some of the interacting variables that enter into the question of optimal "size-of-step" in an instructional program are discussed below.

The statement that mastery of a complex subject can best be built up by fairly small steps is a deceptively simple one, even if assumed essentially sound for many purposes. For one thing, the meaning of the terms "step" and "step size" have an awkward way of shifting, depending on the context in which they are used.

The notion of "small steps" may refer to the difficulty of giving a correct response to any item and hence to the probable correctness of the response. For example, it is a large and logically difficult step from the elementary information that electric current flowing through a fine wire heats it up, information contained in the first two items of the 35-item sequence reproduced by Skinner in his 1958 *Science* article, to the relationships between incandescence and emission arrived at by the end of this sequence. But it is a very small step, which the student takes easily, from any one item in the sequence to the immediately succeeding item.

Some of the basic research questions here are how small the steps should be kept at various points in a program, what distribution of successes and failures is most motivating to the student and most effective in correcting incipient error tendencies, and what techniques can be used to control and predict the difficulty of each step in a program. Answers to these questions are intimately related to the way in which cueing and feedback are employed, and the answers may differ depending on the instructional objectives sought.

A second sense in which the notion of "size-of-step" may be applied is an entirely different one: namely, what is the size of the *response segment* which the student is required to perform in response to the question contained in each frame of the program? For example, in a verbal-learning sequence this may be a single letter, a word, or several words. More particularly, we may ask about the magnitude of the required response in terms of the optimal number of elementary components that are emitted by the student before a response is corrected or confirmed. Depending on both the device and the programming practices, this may occur one letter or digit at a time (as in the Rath-Anderson IBM-650 binary arithmetic program referred to earlier).

More commonly, a longer segment is employed before differential reinforcement is provided. This may comprise a "package" answer such as identifies the correct category for a multiple-choice question in a Pressey-type device. Alternatively, it may be the writing in of a word or two in a Skinner free-response machine, or the setting in of a several-digit answer to an arithmetic problem. In the extreme case, as in certain uses of the branching sequences devised by Crowder, the student may be allowed to proceed for a number of frames before he is corrected, so that the "step" he must retrace is actually a sequence of possibly quite lengthy steps.

The pros and cons of such a procedure are especially interesting as research questions because they appear to involve divergent predictions in terms of different theories of learning. For example, theories which stress the importance of immediate differential reinforcement would certainly counterindicate the last-named procedure. The most direct application of such S-R theories would tend to favor element-by-element feedback, but theorists who stress mediational processes and response integration might prefer to let the student complete an integrated response sequence before feedback is provided. As is so often the case, the most difficult aspect of such questions is how to reduce them to their essential elements and to formulate important hypotheses covering these in clear-cut, testable forms.

A somewhat different sense in which "size-of-step" sometimes gets used is perhaps better described as "size-of-frame." One aspect of this is the interval between successive questions to which the learner is asked to respond. This is most commonly only a phrase, or a sentence or two (necessarily not much more in the Skinner-Porter-Pressey types of device, as they are limited by the physical constraints of the aperture). But in other cases (such as some of Glaser and Homme's programmed text frames) there may be a number of sentences. In the scrambled-book or microfilm projection sequences devised in accordance with Crowder's approach, there may even be several paragraphs. In the latter case we have, in effect, deliberately incomplete programming in which several steps are combined into a single step. Dependence is thus placed on implicit rather than on overt responding until near the end of the frame.

Variations in any one, or all three, of these aspects of step size may enter into differences in programming and may interact also with the rationale for frequently-branching versus relatively fixed-sequence programming. The latter is one of the main points which differentiate the approaches used by Crowder, on the one hand, and by Skinner and his followers on the other. A comparison of these two divergent approaches is of particular interest at the present time because of the rather strong arguments advanced by the proponents of each, and because of the fact that both approaches are being actively utilized in constructing programmed material designed for use in on-going courses of instruction.

The two approaches have in common the three basic factors of individually paced instruction, active response and immediate feedback. Also, both attempt to create a self-sufficient instructional program which will produce mastery of a subject when used as the sole primary vehicle of instruction. In addition, since both have been applied primarily to the programming of logically interrelated verbal or symbolic material, both tend to be based on a logically sequenced arrangement of the elements of the subject, in which new concepts are built up gradually on the basis of more elementary material through which the student is first carefully led in order to try to make sure he masters each prerequisite step before proceeding. (Both can thus be differentiated from the approach mainly followed by Pressey's students and currently exemplified in a number of "self-scoring tests" which seek only to provide adjunctive study-quiz materials rather than a comprehensive, fully ordered and self-sufficient instructional package.) Finally, it may be noted that both Crowder's approach and that of the Skinner school may be implemented more or less advantageously either with more complex mechanical devices for controlled presentation and regulation of the program, or by means of an inexpensive book-format in which some degree of automaticity and control is sacrificed.

Despite these similarities the differences between the two approaches are very considerable. One tends to use multiple-choice questions, the other stresses "constructed" responses composed by the student. This difference is fairly consistent, though it should be noted that it is not necessarily an inevitable concomitant of the use of branching versus non-branching sequences. A second difference is in the fact that the Crowder programs use longer frames (more verbal expository material for each question to which the student responds overtly); this also means that more of the learning from the program is left up to mediation by implicit rather than overt response. The Crowder programs also show a tendency to make many of the steps in the program represented by each frame difficult enough to challenge the superior student, allowing other students to make errors which are then corrected by digression to a remedial sequence. This is a basic difference in rationale which underlies the two approaches. The capability of the Crowder type of program for providing branching sequences is also felt essential by some in order to explain to the student the basis for his errors -- errors which the Skinner type of program tries to prevent from occurring in the first place by making all steps easy enough for virtually all students to get them correct.

A final crucial difference between the two approaches, partly related to the foregoing differences, is the role which is emphasized for the overt responses made by the student as he works through a program. The combination of features that distinguishes most of the branching programs devised by Crowder and those who follow his general approach implies that this role is primarily one of testing to check on the knowledge which the student is expected to have acquired through implicit responses to textual material in each frame of a program. On the contrary, a basic assumption underlying the rationale employed in the programs constructed by Skinner and his associates (as well as numerous others who have begun writing self-instructional programs following his general approach) is that elicitation of appropriate overt responses by the student is *per se* a process through which the responses will be most effectively learned. In this rationale, moreover, the assessment or testing function is minimized, particularly to the extent that the programmer succeeds in achieving a program which can remain motivating to brighter students while preventing even the slow student from making more than a minimal number of errors.

It may be noted that the emphasis on learning through active response implied here is not restricted to implying a theoretical position which gives primacy to immediate reinforcement as the most directly crucial condition for effective learning to occur. The same emphasis follows also from contiguity theories, such as those enunciated by Guthrie, Estes and others, which stress only the need to get the appropriate response from the learner. From either point of view, it is the programmer's aim to elicit the desired responses *in order to effect learning thereby* rather than primarily for the purpose of testing to see if learning has occurred.

To resolve these and other issues in the rationale for program construction and in the determining of optimal device characteristics, research needs to be formulated at the level of dealing with basic variables in the psychology of human learning as these could apply in meeting practical educational objectives. Such research can not only contribute to our basic understanding of the learning process but can also, because of the degree of control afforded in programmed instruction, be translated directly into guidelines which can make direct contributions to the achievement of more effective conditions of learning by students in our schools. At the present time, there appear to be two paramount requirements for our progressing toward full realization of the promise inherent in programmed learning by means of teaching machines and related devices. The first requirement is the active development of adequate programs in a variety of subject matters that can be tried out and "road-tested" in practical instruction. It can be argued that until this has been done there is little point in continuing to develop and market more machines (except for research purposes), since the machines are useless until there are programs for them to present. The second important need is to design and conduct research that can clarify the operation of basic variables which determine the best methods for programming to meet various kinds of instructional problems, and which will generate the specifications on which future teaching machines and programs should be based. Such research needs to deal with specific variables and their interactions.

It is unlikely that over-all "evaluative" comparisons of loosely defined "types" of devices or classes of programs will contribute much of permanent usefulness to either the science of learning or the technology of programmed instruction. What is needed, rather, is a vigorous effort in programming development, backed up by carefully conceived experimental studies of basic variables. With a sustained, massive effort in these two complementary directions, improvements of a truly revolutionary character in the effectiveness of both academic and technical instruction might well be a prospect within the span of the next decade.

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